# Accumulation of Pollutants in Fish and Shellfish from the Northwest Florida Region

**FINAL REPORT**


**Principal Investigators:**

Dr. Richard A. Snyder[1]
Professor and Director

Natalie Karouna-Renier[1,2]
Research Associate

[1]Center for Environmental Diagnostics and Bioremediation (CEDB)
Bldg 58, Room 70
University of West Florida
Pensacola, FL 32514

850-474-2060
http://uwf.edu/cedb
rsnyder@uwf.edu

[2]current address:
Research Ecologist
USGS Patuxent Wildlife Research Center
BARC-East, Building 308
10300 Baltimore Avenue
Beltsville, MD 20705


30 September 2009

## Table of Contents

## List of Tables



## List of Figures

# I. Introduction

## A. *A Regional Perspective*

Aquatic organisms bioaccumulate and bioconcentrate environmental pollutants, which over time may be concentrated to levels that cause physiological impairment in humans from consuming fish and shellfish. Segments of the human population with increased toxic exposure risk include consumers of commercially harvested seafood, recreational fishers, and segments of society that may rely on harvestable species for subsistence. Significant quantities of fish and shellfish are harvested both commercially and recreationally within the Pensacola Bay System and near coastal waters, and sporadic previous work has documented contamination in the system with PCBs, Dioxins, and metals (Duke et al., 1970; Wilson and Forester, 1978; Oliver et al., 2001, Lewis et al., 2001; DeBusk et al., 2002). A comprehensive survey of contaminants in seafood has not been conducted in the region, or in the State of Florida.

Monitoring of fish and shellfish tissues is common throughout the country as an indicator of potential human exposure to contaminants in sediments and water. These analyses are used for the establishment of consumption advisories for specific species and size classes in specific regions or water bodies. The State of Florida has established fish consumption advisories mainly for mercury in most freshwaters and for selected marine species, with limited advisories for dioxins, pesticides and contamination by PCBs. However, contamination by PCBs, Dioxins/Furans, and PBDEs is receiving increasing attention in Florida (Gelsleichter et al., 2005; Johnson-Restrepo et al., 2005). Assumptions that levels of contamination in the marine environment would begin to decrease with the end of production and use of PCBs have not been validated. Indeed, evidence to the contrary has indicated that PCB levels may be substantially higher now in Bull sharks and Bottlenose dolphins than they were a decade ago (Johnson-Restrepo et al., 2005)

Within the State of Florida, fish consumption advisories exist for methyl mercury in several marine species within the Gulf of Mexico, and for freshwater species found in various rivers and estuarine systems (Adams and McMichael, 2001). Within the Pensacola Bay System, mercury advisories have been established for the major rivers (Escambia, Blackwater, Yellow). Consumption advisories based on mercury concentrations also exist for marine species such as the Spanish and king mackerels, which seasonally enter the Pensacola Bay System.

With a known history of PCB contamination and elevated mercury levels in some fishes, our primary focus was on Polychlorinated Dioxins/Furans (DF), Polychlorinated biphenyls (PCBs), and mercury (Hg) in harvested seafood of the NW Florida region. Other compounds were found to be of minor significance, and this report will focus on DF, PCBs and Hg. In order to better assess the distribution of these compounds in regionally harvested fish and shellfish, data collected in a survey of PCBs and Hg in offshore fishes prior to the sinking of the ex-Oriskany as an artificial reef (http://www.uwf.edu/cedb/Oriskany.cfm), results from CDC-supported PERCH project studies on contaminants in oysters and crabs in the Pensacola Bay System, and contaminants in largemouth bass from regional lakes and ponds are also included in this report.

## B. *PCBs, DF, and Hg*

Polychlorinated dibenzo-p-dioxins, with potentially 75 different chlorinated molecular configurations (congeners), and polychorinated dibenzofurans, with potentially 135 congeners, are by-products of natural and anthropogenic combustion and chemical manufacturing activities, and are collectively referred to in this document as Dioxins/Furans (DF). Polychlorinated biphenyls (PCBs), with 209 possible congeners, were manufactured from 1929 to 1977 as industrial fluids and plasticizers. These compounds are not easily degraded in the environment, and they tend to be hydrophobic and strongly partition into lipids. The tendency to absorb into lipids and fats has been used in modeling biological and environmental behavior of these molecules as partitioning coefficients in octanol-water phases ($K_{OW}$; http://environ.nosc.mil/Projects/REEFEX/index.html). PCB contamination comes from industrial use, spillage, and disposal of these synthetic compounds, mostly in freshwaters and estuaries, though some marine disposal has been suspected. PCBs are also known to be deposited from the atmosphere (Park et al., 2001), but this flux is relatively minor compared to direct discharges to aquatic systems (Howell et al., 2007). Distribution of these compounds by highly mobile biota may be significant, yet is poorly understood.
Fish consumption advisories based on mercury (Hg) concentrations in fish are prevalent in both fresh and salt waters. Hg contamination of the marine environment comes mainly from landscape runoff carrying terrestrial deposits of Hg and from atmospheric deposition of combustion-sourced material and dust particles. Elemental Hg is converted to an organic *methyl*-Hg form by sulfate reducing bacteria in anaerobic environments (sediments mostly). The *methyl*-Hg form of Hg accumulates in biota and has toxic properties. Since most of the tissue burden of mercury is in the form of *methyl*-Hg, total Hg content is often used to analyze tissues.

DF, PCBs, and Hg (as *methyl*-mercury) tend to bioaccumulate in both individual organisms with time and with trophic transfers up food webs. With few exceptions, higher concentrations tend to be found in the top level predators. Ecological distribution of concentrations of Hg and PCBs in fish tissues is often not correlated and can be species specific, indicating different sources and dynamics of these compounds in the environment coupled with ecological differences in life history patterns of biota that affect bioavailability, spatial dispersion, and human exposure through harvested seafood.

## C. *Previous documentation of PCBs in Pensacola Bay System*

The Lower Escambia River is the location of a historical point source of PCBs. In the late 1960s, an industrial plant was found to be discharging one to three gallons per day of Aroclor 1254 into the Escambia River from the use of Pydraul AC in air compressors (Parrar et al., 1969). This spill contaminated the biota and sediments of the entire Escambia Bay System to very high levels, and has been documented in the science literature (Tables 1-3). Other studies have found contamination in the urban bayous (Table 1), although no comprehensive survey has been conducted that would prompt action by the State of Florida Department of Health to issue advisories for human consumption of contaminated seafood.

Table 1. Documentation of DF and PCBs in biota and sediment of the Pensacola Bay System.

| Reference | Finding |
|---|---|
| Duke et al., 1970 | PCBs in fish and crustaceans up to 184 ppm; partitioning in fish tissues (liver) from Escambia Bay |
| Nimmo et al., 1975 | Bioaccumulation in hepatopancreas and ventral nerve of Escambia Bay Penaeids and fish. |
| Wilson & Forester 1978 | Escambia Bay oysters with high PCB concentrations, declining over time (1969-1975), highest during spawning |
| Rubinstein et al., 1984 | Dietary contribution more important than PCB sediment contact for Spot via polychaetes. |
| Oliver et al., 2001 | Significant body burdens of PCBs, PAHs, DDT, Chlordane, Zn, and Hg in oysters within Pensacola Bay system. |
| Lewis et al., 2001 | Contamination in Pensacola Bay System bayou sediments, gradient toward open bay |
| DeBusk et al., 2002 | Atlas of previous sediment contamination work |
| Hemming et al., 2002 | Sediment Dioxins TEQs 23.8 in Escambia Bay, 13.57 in S. R. Sound |
| Karouna-Renier et al., 2007 | DF & PCBs in crabs and oysters from Pensacola Bay System |

Table 2. PCB (Aroclor® 1254) in organisms in Escambia Bay (Duke et al., 1970)

| Organism | Location | ppm as Aroclor 1254 |
|---|---|---|
| *Paralichthys sp.* liver | Mulatto Bayou | 76 |
| *Paralichthys sp.* muscle | " | 4.5 |
| *Paralichthys sp.* gills | " | 19 |
| *Micropogon undulatum* | " | 12 |
| *Brevortia patronus* | " | 11-12 |
| *Lagodon rhomboides* | " | 10 |
| *Cynoscion nebulosa* liver | Pensacola Bay | 21 |
| *Cynoscion nebulosa* gills | " | 7.5 |
| *Cynoscion nebulosa* | Northern Escambia Bay | 20 |
| *Paralichthys sp.* liver | " | 184 |
| *Penaeus spp* | Mulatto Bayou | 1.5 |
| *Callinectes sapidus* | Northern Escambia Bay | 2.5-7.0 |
| *Callinectes sapidus* | Mulatto Bayou | 1.0 |

Table 3. PCB (Aroclor® 1254) in organisms in Escambia and East Bays (Nimmo et. al., 1975).

| Organism | Escambia Bay (ppm as Arolclor 1254) | East Bay (ppm as Aroclor 1254) |
|---|---|---|
| *Neritima reclivata* | 0.49 | ND |
| *Penaeus aztecus, P. setiferus* | 0.98 | Trace |
| *Callinectes sapidus* | 6.90 | 0.46 |
| *Anchoa mitchelli* | 3.00 | 0.68 |
| *Arius felis, Bagre marinus* | 3.30 | 0.58 |
| *Menedia berylina* | 10.0 | 0.95 |
| *Bairdiella chysura* | 4.50 | 0.48 |
| *Cynoscion arenarius* | 1.50 | - |
| *Cynoscion nebulosa* | - | 0.12 |
| *Leiostomus xanthurus* | 1.6 | Trace |
| *Micropogon undulatum* | 1.6 | Trace |
| *Trinectes maculatus* | 1.3 | ND |
| *Trichiurus lepturus* | 2.90 | 0.72 |

### *D. Previous documentation of PCBs in the Gulf of Mexico*

Studies on persistent organic pollutants in the Gulf of Mexico have focused mainly on fish from coastal systems (Kennicutt et al., 1988; Harvey et al., 2008) or stranded bottlenose dolphins along Gulf beaches (Wells et al., 2005). From a public health perspective, mercury is the only toxicant that has received attention in Florida marine fisheries. Work conducted by EPA (EMAP; Harvey et al., 2008) and NOAA (Wade et al., 1988) in Gulf estuaries has documented widespread contamination by trace metals and persistent organics, including PCBs, associated with human activity. Recently, NOAA (Krahn et al., 2005) tested some organisms in Mississippi Sound due to public concern for offshore pollutant transport from hurricane Katrina flooding and concluded that the levels of contaminants were below levels for concern.

Despite the lack of attention paid to PCB contamination along the Gulf Coast, PCBs are of particular concern because of their toxicological effects and due to their ability to be accumulated by biota. Bioaccumulation is manifested in fish as body burden increases with age and with trophic level such that environmental contamination that might not trigger concern may result in unacceptable levels of PCBs in harvested fish. For example, despite a comprehensive analysis of sediments indicating few areas for concern, recent work in San Francisco Bay has resulted in a fish consumption advisory for PCB body burdens in top level predatory fish (http://www.epa.gov/region9/water/dioxin/sfbay.html). Data on bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Mexico showed that males accumulate high concentrations of PCBs in blubber with age (>100 ppm). However females show much lower and relatively stable levels as a result of depuration by birth of offspring and lactation (<15 ppm; Wells et al., 2005). Similar dynamics as a result of egg production in fishes has not been shown.

Along the northern Gulf Coast, PCBs have been reported from Loggerhead turtles (Alam and Brim, 2000), bottlenose dolphins (Salata et al., 1995; Watanabe et al., 2000; Wells et al., 2005; Johnson-Restrepo et al., 2005), and bony and cartilaginous fishes in coastal waters (Geleichter et al., 2005; Johnson-Restrepo et al., 2005) indicating that connectivity between estuarine and offshore food webs may serve as a conduit for translocating contaminants, including PCBs, offshore. Analysis of PCBs in other biota of the offshore environment of the northern Gulf of Mexico has been limited, and mostly date to the 1970s. Table 4 lists available data, including: benthic invertebrates (rock shrimp), net plankton (>200 µm), and relatively few fishes. Values for grouper are plotted in Figure 1. It should be noted that quantification of PCBs as Aroclors, as reported in these studies, has been shown to underestimate total PCBs by as much as five fold (Connor et al., 2005).

Table 4. PCB body burdens (ng/g) in biota from the northern Gulf of Mexico.

| **Species** | Location | wet wt | lipid | Reference | notes |
|---|---|---|---|---|---|
| Rock shrimp | Off Pensacola (30 00.5'; 87 17.5') | 6 | | Giam et al., 1972. | quantified as Aroclor 1260 |
| Net plankton | Off Pensacola (30 00.5'; 87 17.5') | 157 | | Giam et al., 1973 | quantified as Aroclor 1260 |
| Net plankton | Off Cape San Blas (29 19.5'; 83 28.0') | 1055 | | Giam et al., 1973 | quantified as Aroclor 1254 |
| Plankton | Off Pensacola (29 19'; 87 01') | 0.1 | 112.359 | Baird et al., 1975 | quantified as Aroclor 1254 |
| Mesopelagic fish | Off Pensacola (29 19'; 87 01') | 0.033, 0.158, 0.040 | 12.027, 4.313, 3.418 | Baird et al., 1975 | quantified as Aroclor 1254 |
| Plankton | Off Pensacola (29 26'; 87 17') | 0.157 | 19.087 | Baird et al., 1975 | quantified as Aroclor 1254 |
| Grouper | 18 samples GOM | 33 | | Giam et al., 1974 | quantified as Aroclor 1260 |

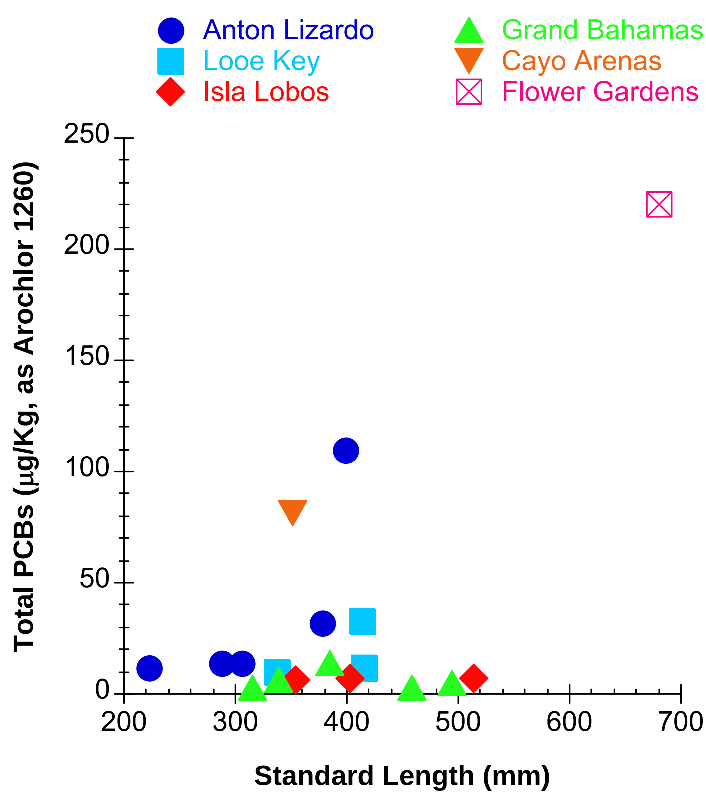



Figure 1. PCB body burdens in groupers from the Gulf of Mexico, Florida Keys and Bahama Islands. The only sample close to the northern Gulf of Mexico is the Flower Gardens (Pink X square), likely impacted from coastal Louisiana and Texas. Data plotted from Giam et al., 1974.

## E. *PERCH goals and overall approach*

As part of our PERCH (Partnership for Environmental Research and Community Health) project, this study was initiated to assess the potential for human exposure to toxic substances in the environment from consumption of harvested fish and shellfish in the Pensacola Bay area. Most animal exposure to environmental toxins is through eating contaminated foods. People in the Northwest Florida region consume significant quantities of fish and shellfish harvested from regional waters by individuals (recreational) or commercial operations (see Tables 5 and 6). Previous studies have documented both sediment and regional biota contamination with Dioxins-Furans, PCBs, pesticides, herbicides, and metals, and some reports have documented contamination in regional biota as noted in the previous section. Many of the common contaminants can be bioaccumulated in organisms due to retention rates exceeding depuration rates with age, and due to bioconcentration with trophic transfers up the food chains. Thus the oldest/largest and top predatory species tend to have the highest body burdens of toxic materials and present the greatest risk to consumers.

In order to assess regional contamination patterns, specific guidelines for conducting body burden assessments for harvestable fish and shellfish species promulgated by the US EPA with the help of the American Fisheries Society (USEPA, 2000) were followed in this investigation. Screening values from that document were used to assess critical levels of contamination, with the recreational consumption screening values, based on one 4.3 oz meal per week: $TEQ_{DFP}$ = 0.256 ng/kg, Total PCBs = 20 μg/kg, Hg = 0.4 mg/kg. State of Florida screening values based on a single 8 oz meal per week for the general population were also indicated in some data presentations: $TEQ_{DFP}$ = not established, Total PCBs = 50 μg/kg, Hg = 0.6 mg/kg. Data were not accepted into analysis unless the measured concentrations were greater or equal to 5 times the blank values for each analysis lot. Non-detects (ND) were substituted for ½ the reported detection limits (DL) and were also treated as zero values. This report mostly presents ND = 0 values, although ND = ½ DL values have been used to estimate human health risks in other reports (Karouna-Renier et al., 2007; Karouna-Renier et al., in prep). In the case of ND = 0, estimated maximum possible concentration (EMPC) values were included (see: http://www.gcisolutions.com/1295tn.htm).

In the first phase, a seafood consumption survey was conducted (Section I. F) and two indicator organisms were targeted (Section I. G) with funding from the Centers for Disease Control and Prevention (CDC). American oysters, *Crassostrea virginica*, were chosen as attached filter feeders that would concentrate compounds suspended in the water column. As an attached species, they would provide site-specific information on contaminant bioavailability. Specimens were recovered from bridge pilings and commercial and recreationally harvested oyster beds. Whole oyster tissues were analyzed. Blue crabs, *Calinectes sapidus*, were targeted for their exposure to benthic contamination as predators of benthic prey species and their habit of burrowing into the substrate to hide. Males were targeted for analysis due to the assumption that they would have more site fidelity than females, which migrate to the lower high salinity reaches of the estuary to hatch eggs. Both the muscle tissue and hepatopancreas were analyzed for contaminant loads.

The second phase of the study focused on largemouth bass (*Micropterus salmoides*), and striped mullet (*Mugil cepahlus*), as commonly caught and consumed and widely distributed and abundant species covering the rivers and the bays of the Pensacola and Perdido Bay Systems watersheds.

The third phase of the study targeted other species of estuarine and marine fishes, including those predominantly found within the estuaries, those known to seasonally enter the estuaries, and offshore species commonly harvested and consumed by the public. The complete dataset compiled here also includes samples from a survey of offshore fishes in a separate project (snyder http://www.uwf.edu/rsnyder/reports/Oriskrpt.pdf.

### F. *A survey of public seafood harvest and consumption*

During the first year of the PERCH project, CDC funded a survey to assess both harvest and consumption patterns for regional fish species. This survey was used to choose the fish used for contaminant analysis and to evaluate potential public health risk. A total of 9000 survey forms were mailed out to Escambia and Santa Rosa Counties (4500 each), with 1500 returned (16.6%). Of the total respondents, 264 (17.6%) had harvested fish in the two week period prior to the survey, 875 (58.3%) ate seafood at restaurants, and 770 (51.3%) consumed seafood purchased at retail outlets. This indicates significant exposure of the regional population to harvested seafood and the contaminants contained therein. A summary of the harvested and consumed fish in the NW Florida region from that survey is presented in Table 5. For comparison purposes, the estimated commercial fishery landings from 2008 are presented in Table 6.

Table 5. The top 20 most commonly harvested (recreational) and consumed (from any source) finfish in the Northwest Florida region. Results are from a consumer and fisherman survey conducted by UWF at the beginning of the project.

| **% of total reported caught** | | | **% of total reported eaten** | |
|---|---|---|---|---|
| Spotted Sea Trout | 10.34% | | Snapper | 13.18% |
| Mullet | 8.95% | | Spotted Sea Trout | 12.22% |
| Snapper | 8.55% | | Mullet | 11.90% |
| King Mackerel | 7.55% | | Flounder | 7.07% |
| Red Drum | 7.36% | | Grouper | 6.43% |
| Flounder | 5.96% | | Spanish Mackerel | 6.11% |
| Spanish Mackerel | 5.96% | | Amberjack | 5.79% |
| Grouper | 5.96% | | Red Drum | 5.47% |
| Croaker | 5.77% | | Croaker | 4.82% |
| White Trout | 4.97% | | King Mackerel | 4.50% |
| Triggerfish | 4.77% | | Triggerfish | 4.50% |
| Amberjack | 4.37% | | White Trout | 4.18% |
| Sheepshead | 3.38% | | Sheepshead | 3.54% |
| Shark | 2.39% | | Pompano | 2.25% |
| Pinfish | 2.39% | | Bluefish | 1.61% |
| Hardhead Catfish | 2.19% | | Cobia | 1.61% |
| Bluefish | 1.99% | | Dolphinfish | 1.29% |
| Pompano | 1.99% | | Black Drum | 0.96% |
| Ladyfish | 1.79% | | Blackfin Tuna | 0.96% |
| Gafftopsail Catfish | 1.79% | | Yellowfin Tuna | 0.96% |
| Hardtail | 1.59% | | Shark | 0.64% |

Table 6. Commercial fisheries landing estimates for 2008 for the Pensacola Bay area*.

| Species | Escambia County, FL | Santa Rosa County, FL | Pensacola Bay area total |
|---|---|---|---|
| Mullet | 261,242 | 120,450 | 381,692 |
| Vermillion Snapper | 371,409 | 1,748 | 373,157 |
| Blue crab | 114,596 | 22,216 | 136,812 |
| Brown Shrimp | 132,429 | 580 | 133,009 |
| Red Snapper | 86,344 | 0 | 86,344 |
| Flounder | 19,776 | 1,963 | 21,739 |
| Oysters | 0 | 18,935 | 18,935 |
| Scamp (a grouper) | 11,799 | 0 | 11,799 |
| Amberjacks | 10,546 | 96 | 10,642 |
| Sheepshead | 8,164 | 1,064 | 9,228 |
| White Trout | 7,346 | 660 | 8,006 |
| Croaker | 4,922 | 710 | 5,632 |
| Black Drum | 4,108 | 313 | 4,421 |
| Squid | 3,522 | 0 | 3,522 |
| Spot | 3,337 | 162 | 3,499 |
| Gag (a grouper) | 3,059 | 8 | 3,067 |
| Spanish Mackerel | 1,642 | 589 | 2,231 |
| Red Grouper | 1,935 | 0 | 1,935 |
| Whiting | 1,713 | 54 | 1,767 |
| Spotted Seatrout | 653 | 1,087 | 1,740 |
| Triggerfish | 1,424 | 30 | 1,454 |
| Pompano | 960 | 347 | 1,307 |
| King Mackerel | 1,111 | 0 | 1,111 |
| Bluefish | 640 | 149 | 789 |
| Wahoo | 78 | 0 | 78 |

*http://research.myfwc.com/features/view_article.asp?id=19224

**G**. ***Blue crabs* (Calinectes sapidus) *and American oysters* (Crassostrea virginica) *as indicators of regional environmental contamination in the Perdido and Pensacola Bay Systems, NW Florida.***

An initial screening level assessment of contaminants was conducted for blue crabs (*Callinectes sapidus*) and oysters (*Crassostrea virginica*) collected from various locations in bays and bayous in the Pensacola, FL area. Tissue samples were analyzed for mercury, arsenic, cadmium, chromium, copper, lead, nickel, selenium, tin, zinc, 17 dioxin/furan compounds, and 12 dioxin-like PCB congeners (PCB-77, PCB-81, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156, PCB-157, PCB-167, PCB-169, and PCB-189). Contaminant levels were compared to Screening Values (SV) calculated using the U.S. EPA recommendations for establishing consumption advisories. Four different consumption rates were used in the derivation of the SVs.

Five chemicals of concern (dioxins/furans/PCBs, arsenic, mercury, cadmium, and zinc) were identified in either crab muscle, crab hepatopancreas, total crab tissue, or oysters based on exceedence of one or more SVs. Health risks (non-carcinogenic and carcinogenic) that may arise as a result of consumption of these shellfish species were also assessed. DF/PCBs accounted for 85-99%, 60-90%, 27-94%, and 53-99% of the total excess cancer risks for crab hepatopancreas, total edible crab tissue, crab muscle, and oysters, respectively. The relative contributions of dioxins/furans and dioxin-like PCBs to the TEQs and resultant risks varied with location, as evident from analysis of the crab hepatopancreas samples. DF were greater contributors in samples from Bayou Chico and Perdido Bay, whereas PCBs were dominant in Bayou Grande and Western Escambia Bay. The locations that exceeded SVs and had the highest carcinogenic or non-carcinogenic health risks were generally located in urbanized waterbodies (Bayou Texar, Bayou Grande, and Bayou Chico) or downstream of known contaminated areas (northern and western Escambia Bay; Figure 2). Oysters collected from commercial oyster beds in Escambia and East Bays, and crabs collected from East, Blackwater, and Perdido Bays generally had the lowest levels of contaminants. Crab hepatopancreas had approximately 25 times the toxicity of crab muscle (Figure 3). Despite accounting for only 15% of the total tissue, inclusion of hepatopancreas in a crab meal increased contamination to levels above many SVs, and therefore, direct or indirect consumption of hepatopancreas from crabs in the Pensacola Bay system should be discouraged. Further investigation is warranted to determine whether consumption advisories should be issued for shellfish from specific locations in the Pensacola Bay System.

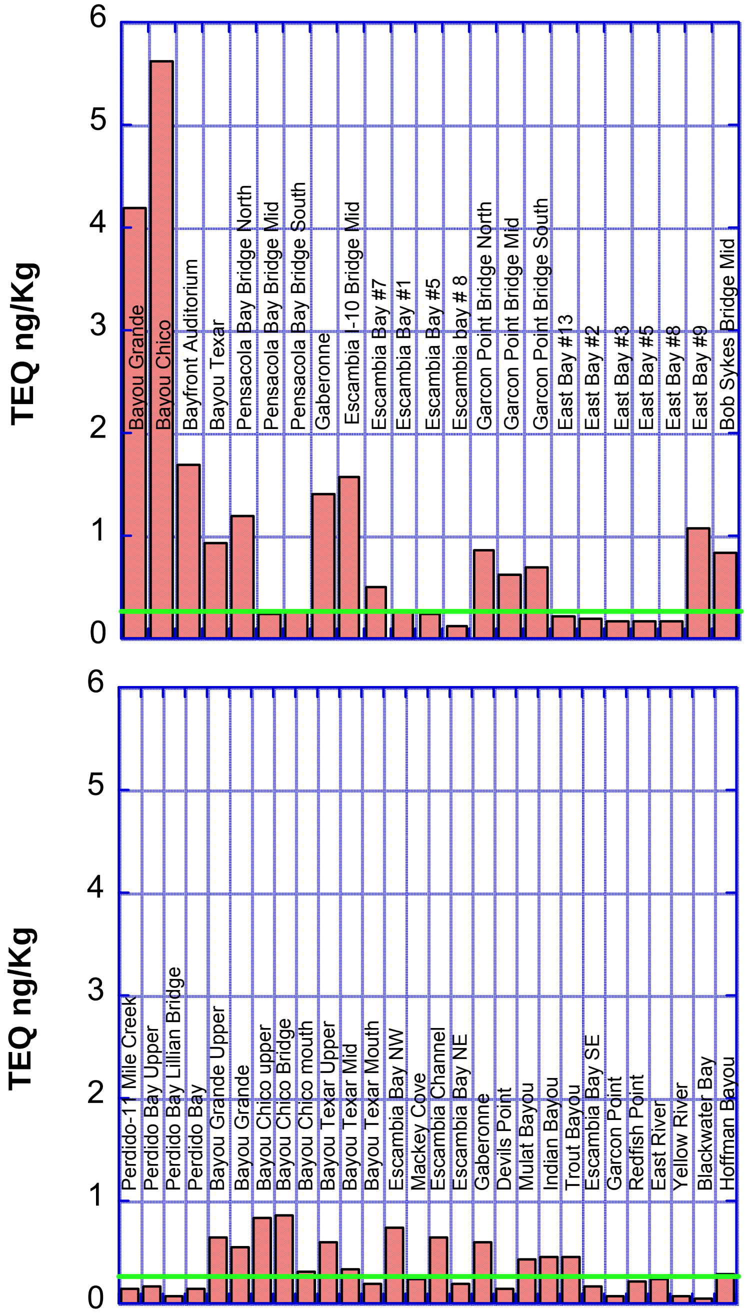



Figure 2. Total TEQ values for oysters (top) and crab muscle tissue (bottom) by location within the Pensacola Bay region. The green line represents the US EPA screening value for recreational fisher consumption.

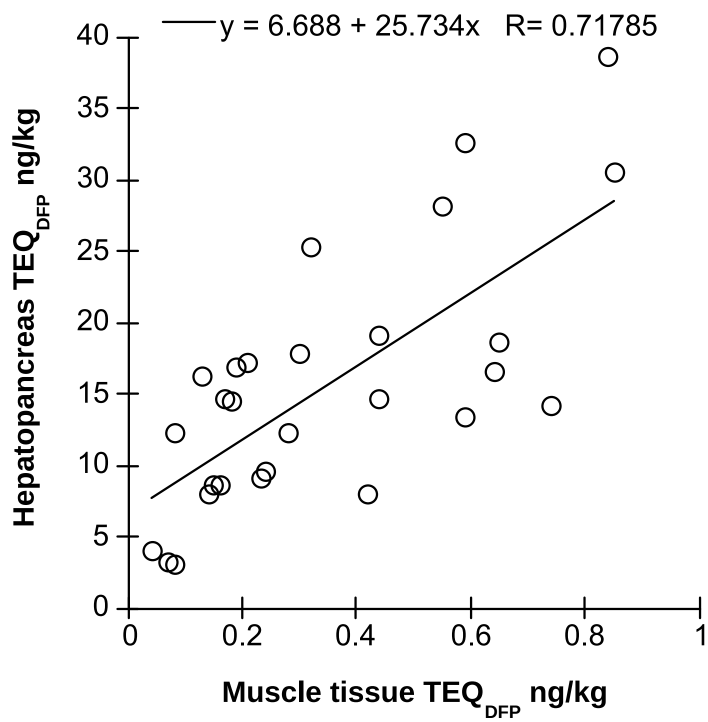



Figure 3. Correlation between TEQ values for crab muscle and crab hepatopancreas. The slope estimate suggests that, on average, hepatopancreas will contain 26 times the TEQ of the crab muscle tissue.

## II. Largemouth bass (*Microterus salmoides*) and striped mullet (*Mugil cephalus*) as sentinels of environmental contamination in Northwest Florida watersheds.

The Second phase of the study targeted two fishes as indicators of bioavailable contaminants. Striped mullet (*Mugil cepahalus*) was chosen as a ubiquitous and abundant estuarine fish indicator species, harvested and consumed in large quantities by the local population. Largemouth bass (*Micropterus salmoides*) was chosen as a freshwater indicator species as a ubiquitous and sought after recreational sport fish. These two species overlap ranges, with mullet ascending into freshwaters, and bass entering the low salinity parts of the estuaries, providing coverage of the watersheds of the region.

### A. *Natural history of target species*

***i. Largemouth bass.*** *Micropterous salmoides* is a common freshwater carnivore and highly sought after as a recreational fishery species. Largemouth bass are primarily piscivores as adults switching from invertebrate prey to fish in their first summer (Ludsin and DeVries, 1997; Post, 2003), making them susceptible to bioaccumulation of toxic materials as both individuals and via trophic transfer magnification. Consumption advisories for mercury content are common for this species and, in the State of Florida, nearly all freshwaters have an advisory for limited consumption, with a few locations with a non-consumption advisory. Males establish nests in shallow areas where eggs are laid and guarded. Largemouth bass are territorial and have limited home ranges (Lewis and Flickinger, 1967; Mesing and Wicker, 1986; Ahrenstrorff et al., 2009), and they return to these home ranges after seasonal migrations to deeper waters (Lewis and Flickinger, 1967) and following capture and relocation within the same water body (Hasler and Wisby, 1958) making them fairly sedentary as adults. Largemouth bass are known to tolerate low salinity (4 ‰) where rivers enter estuaries. Males tend to live to 5-7 years, females to 10 years (Padfield, 1951).

***ii. Striped mullet.*** *Mugil cephalus* is a common saltwater species along the Gulf of Mexico coastline, and has been historically and currently heavily harvested as both a commercial and recreational species along the Gulf coast (Matthews, 1928; Rivas, 1980). Consumption rates by locals are high, as the fish is abundant, easily caught, relatively inexpensive to buy, and popular in restaurants and fish fry events. Large schools of these fish congregate in the lower estuaries every fall and move *en masse* out to the shelf break in the Gulf to spawn during November to March, correlated with tidal amplitude and northerly winds (Ibáñez and Benítez, 2004; Aguirre and Gallardo-Cabello, 2004). Adults return to the estuaries. Juveniles can be found in the tidal creeks, saltmarshes and seagrass beds in the spring, feeding on small crustaceans and insects (Harrington and Harrington, 1961; De Silva, 1980). Adults are found throughout the estuaries and up into fresh waters foraging on algae and detritus along with significant amounts of sediment (Odum, 1970), becoming less selective with age (Eggold and Motta, 1992), and thus are a low trophic level fish in Gulf of Mexico estuaries (Table 7; Akin and Winemiller, 2008). This makes biomagnifications by trophic transfers less likely for this species than accumulation with age as individuals. Striped mullet are thought to live to be about 6 years of age, although most fish are harvested at age two (Rivas, 1980), which may also limit accumulation of contaminants. Due to the refractory nature of their food, adult mullet have a long gut relative to other fishes (Odum, 1970), which may increase absorption efficiency of contaminants in their diet. Tagging studies have suggested some site fidelity despite annual spawning migrations of up to 50 miles, and some evidence suggests populations maybe specific to certain coastal regions or estuaries (Rivas, 1980), although spawning near the Mississippi River Delta may recruit to both the eastern and western Gulf (Ditty and Shaw, 1996).

Table 7. Mean trophic position of estuarine biota (data from Akin and Winemiller, 2008)

| Species | Tropic position by prey | Trophic position by $\delta^{15}N$ |
|---|---|---|
| *Cyprinodon variegatus* | 2.00 ± 0.00 | 2.19 |
| *Adinia xenica* | 2.02 | |
| *Brevoortia patronus* | 2.02 ± 0.00 | 3.65 |
| *Mugil cephalus* | 2.11 ± 0.06 | 2.45 |
| *Penaeus setiferus* | 2.14 ± 0.14 | 2.02 |
| *Dorosoma cepedianum* | 2.17 ± 0.17 | 3.05 |
| *Farfantepenaeus aztecus* | 2.36 ± 0.00 | 1.72 |
| *Fundulus grandis* | 2.34 ± 0.28 | 2.09 |
| *Callinectes sapidus* | 2.58 ± 0.24 | 2.66 |
| *Leiostomus xanthurus* | 2.93 ± 0.09 | 3.31 |
| *Cynoscion arenarius* | 3.14 | |
| *Cynoscion nebulosus* | 3.20 ± 0.04 | 3.28 |
| *Micropognias undulatus* | 3.07 ± 0.19 | |
| *Parachlithys lethostigma* | 3.27 ± 0.18 | 3.27 |
| *Scianops ocellatus* | 3.40 ± 0.19 | 3.29 |

### B. *Materials and Methods*

Several sampling methods were employed for fish collection including: 1) cast net for striped mullet (*Mugil cephalus*), 2) electrofishing for both mullet and largemouth bass with the aid of the State of Florida Fish and Wildlife Research Institute, Fish and Wildlife Conservation Commission, Holt Fish Hatchery personnel, 3) hook and line for bass, and 4) an underwater demolition explosion on the I-10 bridge crossing the middle of Escambia Bay yielding a variety of estuarine species in addition to mullet.

Multiple composite samples of filleted target species were analyzed from each location. The I-10 bridge samples were analyzed as individual fish. All fish were handled with gloved hands. Location, date and time of sampling and fish length were recorded in the field, and multiple specimens were sorted into similar-sized composite samples. Specimens were wrapped in foil and placed in sealed plastic bags on ice with identification labels for transport to the laboratory for processing. In the laboratory, fish were re-measured and weighed. All processing equipment was washed in mild soapy water, rinsed in a sequence of hot tap water, ethanol or propanol, and purified water. Foil sheets were used to cover cutting boards and to handle fillets. Stainless steel fillet knives were used to collect bone- and skin-free samples. Total fillet weight was recorded, tissues were macerated in a Foss Tecator tissue homogenizer, and a minimum of 200 g homogenized tissue added to certified, clean sample jars. Tissue samples were kept frozen until transport on ice to Pace Analytical Laboratories, MN for analysis of organics: Dioxins-Furans (DF), Polychlorinated Biphenyls (PCBs), DDT and its derivatives (4,4-DDD, 4,4-DDE, 4,4-DDT) Dieldrin, γ-Chlordane, Heptachlor Epoxide, and metals: mercury (Hg), Arsenic (As), Inorganic Arsenic (In. As). Toxic equivalent quotients (TEQ) were calculated for DF ($TEQ_{DF}$), Dioxin-like co-planer PCBs ($TEQ_{P}$), and combined DF and Dioxin-like PCBs ($TEQ_{DFP}$). The revised toxic equivalent factors (TEF) for these compounds were used for the TEQ calculations (Van den Berg et al., 2006).

## C. *Results and Discussion*

### *i. Largemouth bass*

Metals (other than mercury), and pesticide/herbicide residues did not emerge as important contaminants in this region. Mercury (Hg) levels in largemouth bass were high in seventeen of the twenty-one locations sampled (Tables 8, 9; Figure 5) with only four locations having concentrations of total mercury below the US EPA recreational threshold of 0.4 mg/Kg. These sample locations included the Tiger Point wastewater treatment plant (WWTP) effluent flow through pond, a stocked pond in northern Santa Rosa County (Bear Lake), and from a quarry pit pond near Bayou Chico, and from 11-mile creek. The WWTP and 11- mile creek are both dominated by ground water sources from municipal and industrial well sources respectively, which may explain their low levels. The low levels of Hg in Bear lake fish may be due to fish being hatchery-raised. Four additional composites were below the State of Florida threshold at 0.6 mg/kg Hg. These samples included three lake samples and one from the lower Escambia River. In Woodbine Lake, three bass composites were above the State of Florida limit for a no consumption advisory (1.5 mg/kg) at 1.6, 2.3 and 2.5 mg/kg). These anomalously high values in a flowing spring fed pond system likely reflects a geologic source of Hg.

Total Polychlorinated biphenyl (PCB) content in large mouth bass was low for all sample locations except the Escambia River Delta (Table 8; Figure 5). Muscle tissue burdens in bass from the Escambia River delta exceeded the US EPA recreational screening value (20 μg/kg), ranging from 23.4 to 61.0 μg/kg in four composites. Average composite fish ages were 2 to 4.3 years, average composite fish lengths were 320 to 337 mm, and average composite fish weights were 401 to 517 g (0.88 to 1.14 lbs), indicating relatively young and small fish for this species. These results prompted the State of Florida to establish a threshold for fish consumption advisories based on PCB content (50 μg/Kg). Two of the bass composites from Escambia River delta exceeded that limit. The next highest PCB content was recorded in a single fish at a flow though holding pond for a waste water treatment plant (WWTP) at 11.2 μg/kg and a three-fish composite (10.324 μg/Kg ) from a quarry pit reported to have received dredge spoil from Bayou Chico.

Dioxins/Furans (DF) content, represented as the toxic equivalent concentration (TEQ) for specific congeners, but not including the co-planar "dioxin-like" PCBs, was low for largemouth bass throughout the area, with two sites yielding composite samples above the US EPA TEQ screening threshold for recreational fisher consumption (0.256 ng/kg). Upper Escambia River had a composite with $TEQ_{DF}$ of 0.46 ng/kg, and the lower Yellow River had a composite with a

$TEQ_{DF}$ of 0.56 ng/kg. Despite high PCB content, samples from the lower Escambia River were at the threshold but no higher. Also unexpected was the low $TEQ_{DF}$ (0.155ng/kg) value for bass recovered from 11-mile creek off Perdido Bay, which is dominated by effluent from a paper mill and has high sediment DF levels (Hemming et al., 2002), presumably from previous chlorine bleaching processes.

In general, larger, older fish had higher bioaccumulation of contaminants. However, any overall accumulation with age was also affected by the site-specific characteristics of contaminant bioavailability, and accentuated by the limited home ranges of these fishes in open waters (Figure 5). Woodbine Lake samples (Figure 6) had very high mercury content in relatively small fish. For PCBs, relatively small fish in the lower Escambia River had the highest PCB loads. Only the bass caught in the lower river locations downstream of the 1969 spill had significant PCB loads, while those caught upstream of the spill location had near background PCB loads.

Table 8. Summary data for largemouth bass *Micropterus salmoides* collected in river systems of NW Florida. Bold values exceed US EPA screening values for recreational fisher consumption.

| Location | n | Mean Length (mm) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg |
|---|---|---|---|---|---|---|---|---|
| 11 Mile Creek | 3 | 335 | 0.3 | 0.0161 | 0.0011 | 0.0172 | 2.62 | 0.32 |
| 11 Mile Creek | 3 | 321 | 0.1 | 0.0727 | 0.1175 | 0.1902 | 4.89 | **0.42** |
| 11 Mile Creek | 3 | 260 | 0.1 | 0.1045 | **0.3546** | **0.4591** | 4.71 | 0.36 |
| 11 Mile Creek | 1 | 439 | | | | | 3.115 | 0.3667 |
| Blackwater River Lower | 4 | 367 | 0.1 | 0.0474 | 0.251 | **0.2984** | 8.27 | **0.58** |
| Blackwater River Lower | 4 | 329 | 0.2 | 0.0062 | 0.0569 | 0.0631 | 2.67 | **0.58** |
| Blackwater River Lower | 3 | 352 | 0.2 | 0 | 0.0678 | 0.0678 | 2.12 | **0.55** |
| Blackwater Upper | 3 | 371 | 0.2 | 0.0422 | 0.0001 | 0.0423 | 0.872 | **1.02** |
| Blackwater Upper | 4 | 304 | 0.5 | 0.0598 | 0.0575 | 0.1173 | 0.841 | **0.76** |
| Escambia River Lower | 4 | 322 | 0.3 | 0.026 | **2.5088** | **2.5348** | **61** | **0.45** |
| Escambia River Lower | 4 | 320 | 0.1 | 0.183 | **0.4273** | **0.6103** | **23.4** | **0.47** |
| Escambia River Lower | 1 | 326 | 0.1 | 0.1236 | **1.6401** | **1.7637** | **45.4** | **0.46** |
| Escambia River Lower | 1 | 337 | | | | | **52.697** | **0.4601** |
| Escambia River Quintette Bridge | 3 | 341 | 1 | **0.355** | **0.8059** | **1.1609** | 1.64 | **0.53** |
| Escambia River Quintette Bridge | 4 | 244 | 0.8 | 0.101 | 0.0005 | 0.1015 | 1.58 | **0.6** |
| Escambia River Quintette Bridge | 4 | 407 | | **0.3495** | 0.0003 | **0.3498** | 1.41 | |
| Escambia River Quintette Bridge | 3 | 396 | | | | | 0.807 | **0.5643** |
| Perdido River, Lower | 3 | 454 | 0.2 | 0.227 | 0.1687 | **0.3957** | 4.32 | **0.63** |
| Perdido River, Lower | 4 | 334 | 0.1 | 0.0709 | 0.1232 | 0.1941 | 4.24 | **0.45** |
| Perdido River, Lower | 3 | 388 | 0.2 | 0.097 | 0.1251 | 0.2221 | 3.34 | **0.6** |
| Perdido River, Lower | 1 | 485 | | | | | 2.912 | **0.5605** |
| Perdido River, Upper | 3 | 374 | 0.2 | 0.0843 | 0.0004 | 0.0847 | 1.28 | **0.81** |
| Perdido River, Upper | 3 | 421 | 0.1 | 0.0866 | 0.0053 | 0.0919 | 2.87 | **0.86** |
| Perdido River, Upper | 4 | 330 | 0.2 | 0.0995 | 0.0969 | 0.1964 | 2.17 | **0.65** |
| Shoal River | 4 | 305 | 0.5 | 0.103 | 0.0078 | 0.1108 | 3.36 | **0.47** |
| Shoal River | 3 | 355 | 0.4 | 0 | 0.0002 | 0.0002 | 1.51 | **0.77** |
| Shoal River | 3 | 413 | 0.7 | 0.114 | 0.0005 | 0.1145 | 1.25 | **0.64** |
| Yellow River Lower | 3 | 373 | 0.1 | 0.014 | 0.0467 | 0.0607 | 1.09 | **0.7** |
| Yellow River Lower | 3 | 341 | 0.2 | 0.173 | 0.0144 | 0.1874 | 7.33 | **0.81** |
| Yellow River Lower | 4 | 309 | 0.2 | 0.05 | 0.0003 | 0.0503 | 1.67 | **0.6803** |
| Yellow River Upper | 3 | 424 | 2.8 | **0.285** | 0.0004 | **0.2854** | 0.971 | **0.74** |
| Yellow River Upper | 3 | 361 | 1.2 | 0.1215 | 0.0047 | 0.1262 | 2.54 | **0.74** |
| Yellow River, Upper | 4 | 346 | 0.56 | 0.0515 | 0.0543 | 0.1058 | 1.98 | **0.65** |

Table 9. Summary data for largemouth bass *Micropterus salmoides* collected in ponds of NW Florida. Bold values exceed US EPA screening values for recreational fisher consumption.

| Location | n | Mean Length (mm) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg |
|---|---|---|---|---|---|---|---|---|
| Bayou Chico Pond | 3 | 366 | 0.2 | 0.017 | **0.8609** | **0.8779** | 10.324 | 0.035 |
| Bear Lake 1 | 3 | 362 | 0.4 | 0.0678 | 0 | 0.0678 | 0.774 | **0.41** |
| Bear Lake 2 | 3 | 330 | 0.5 | 0.0671 | 0 | 0.0671 | 0.55 | 0.34 |
| Bear Lake 3 | 3 | 338 | 0.6 | 0.0127 | 0 | 0.0127 | 0.665 | 0.34 |
| Cedar Lakes | 3 | 348 | 0.2 | 0.0171 | 0.0002 | 0.0173 | 2.058 | **0.84** |
| Fairfield Pond | 3 | 362 | 0.1 | 0.013 | | | 3.776 | **0.57** |
| Fairfield Pond | 1 | 532 | 0.2 | 0.0479 | | | 8.281 | **1.3** |
| Fairfield Pond | 3 | 332 | 0.3 | 0.009 | 0.0026 | 0.0116 | 4.32 | **0.66** |
| Hurricane Lake | 1 | 340 | 0.2 | 0.0049 | 0.0001 | 0.005 | 0.879 | **0.42** |
| Lake Kristina | 3 | 307 | 0.2 | 0.01 | 0.0001 | 0.0101 | 0.161 | **0.43** |
| Lake Stone 1 | 4 | 345 | 0 | 0.0064 | 0 | 0.0064 | 0.728 | **0.51** |
| Lake Stone 2 | 4 | 331 | 0 | 0.0063 | 0 | 0.0063 | 0.666 | **0.51** |
| Lake Stone 3 | 4 | 336 | 0 | 0.0085 | 0 | 0.0085 | 0.537 | **0.58** |
| Langley-Bell 4H | 3 | 296 | 1.9 | 0.024 | 0.0002 | 0.0242 | 1.06 | **0.96** |
| Langley-Bell 4H | 1 | 430 | 0.1 | 0.0076 | 0.0002 | 0.0078 | 1.07 | **1.1** |
| Tiger Pt GC | 3 | 332 | 0.2 | 0.02 | 0.0025 | 0.0225 | 4.194 | |
| Tiger Pt WWT | 3 | 305 | 0.2 | | 0.1522 | | 3.697 | **0.58** |
| Tiger Pt WWT | 1 | 398 | 0.2 | 0.019 | 0.1524 | 0.1714 | 11.2 | 0.091 |
| Tiger Pt WWT | 1 | 510 | 0.1 | 0.0097 | 0.0029 | 0.0126 | 6.08 | 0.13 |
| Woodbine Lake 1 | 4 | 301 | 0.2 | 0.007 | 0.025 | 0.032 | 1.764 | **1.6** |
| Woodbine Lake 2 | 3 | 321 | 0.2 | 0 | 0.0004 | 0.0004 | 1.241 | **2.5** |
| Woodbine Lake 3 | 3 | 345 | 0.3 | 0.0083 | 0.0012 | 0.0095 | 2.006 | **2.3** |

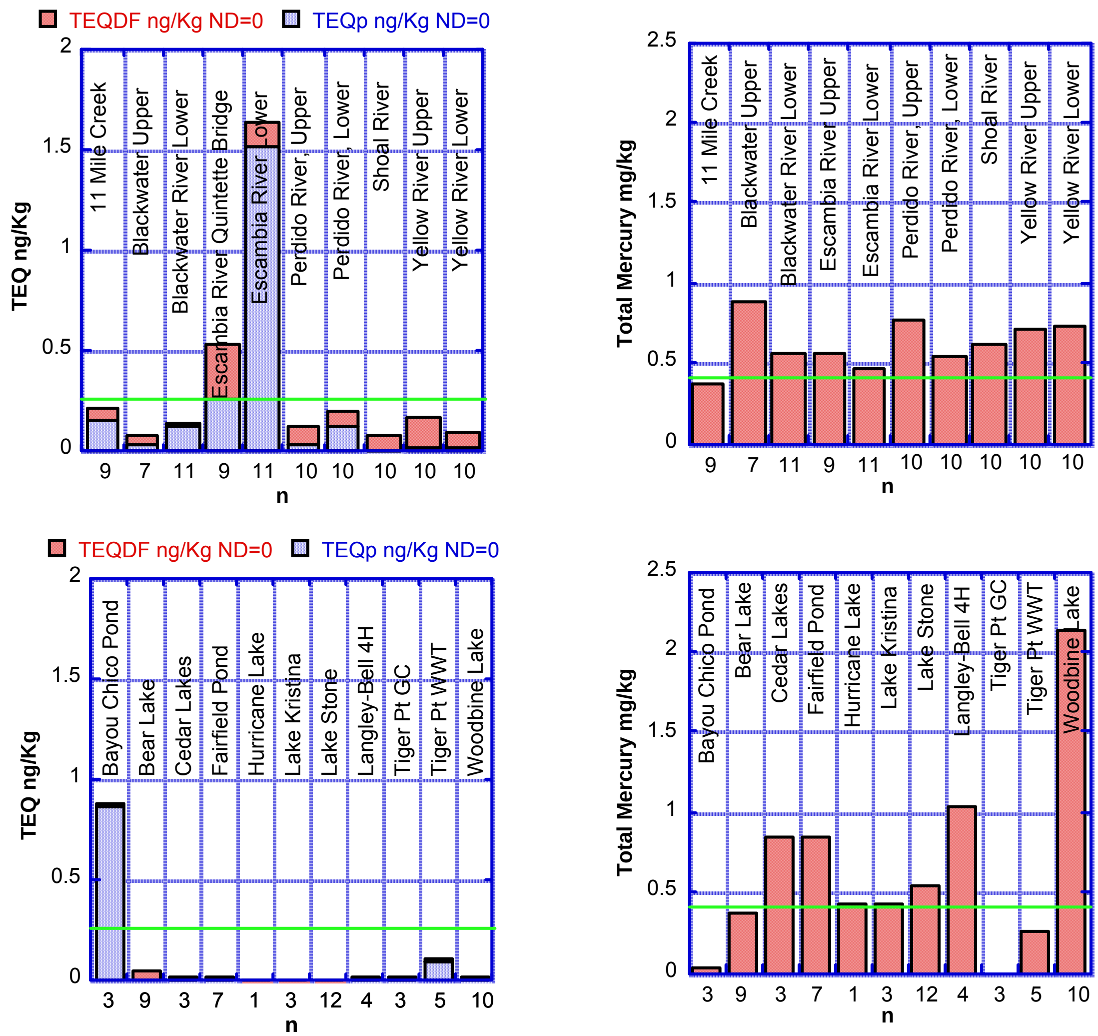



Figure 4. Contaminant loads in largemouth bas in NW Florida waters. TEQ values for the DF ($TEQ_{DF}$; red) and PCB ($TEQ_P$; blue) contributions to the total toxicity equivalent ($TEQ_{DFP}$; entire bar height) in the left column, and total mercury concentrations in the right column in largemouth bass fillets from NW Florida waters. In the top row are data for samples taken from rivers. In the bottom row are data for samples taken from regional ponds. Green lines represent the US EPA screening values for recreational fisher consumption.

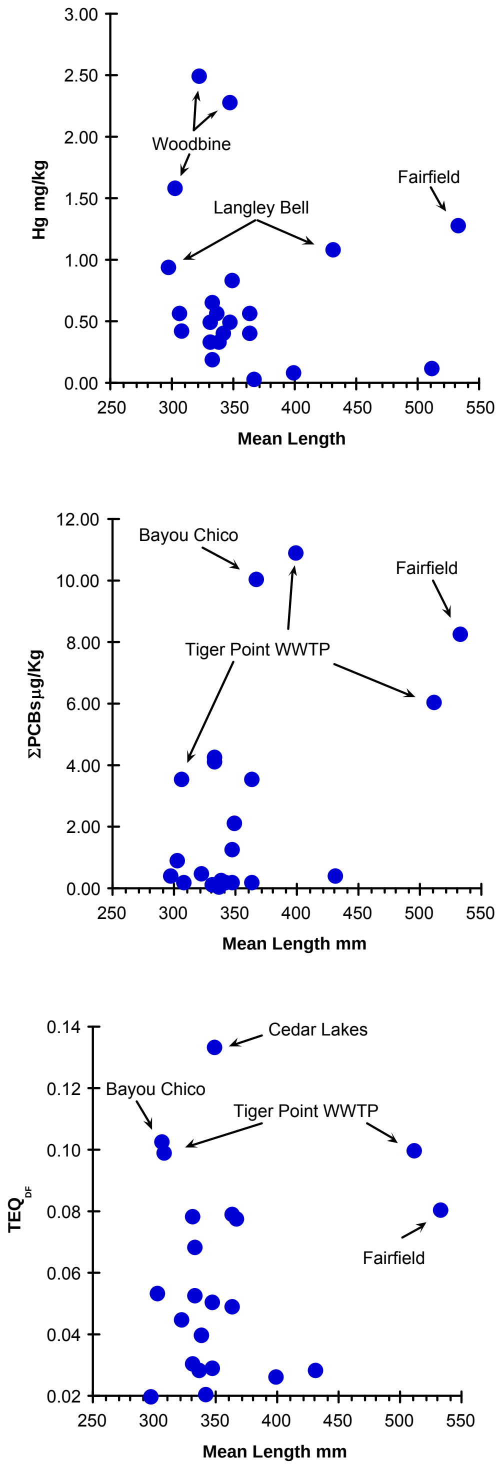



Figure 5. Contaminant concentrations in largemouth bass as a function of fish length as the mean for composites or single fish for larger specimens. Location characteristics mask any overall bioaccumulation with size (age) for the region.

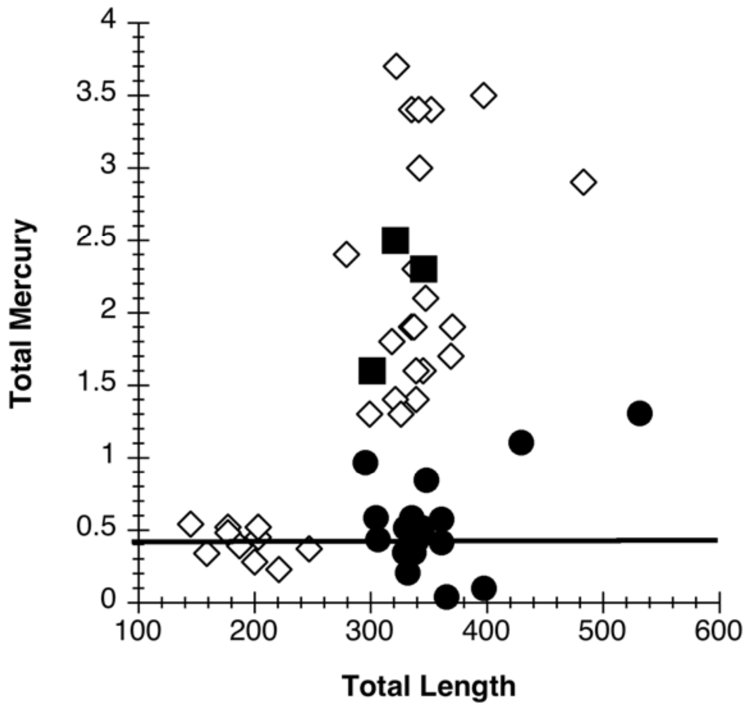



Figure 6. Mercury (mg/kg) in bass data collected over Escambia, Santa Rosa, and Okaloosa Counties (solid circles and squares), compared to multiyear data from the Florida Fish and Wildlife Commission sampling of bass in Woodbine Lake (diamonds). The results from the UWF work for Woodbine Lake are indicated by the solid squares. Data from all other locations sampled by UWF are indicated by solid circles.

***ii. Striped mullet***

Mullet tissue contaminant burdens reflect different environmental exposures than bass. Mercury concentrations in all mullet samples were low (Table 10; Figure 7), perhaps a reflection of their low trophic status relative to largemouth bass, especially where the sample locations for these fish overlapped. PCBs and DFs, however, tell a different story. Both of these compounds had higher concentrations in mullet than bass, for both co-located samples and overall (Table 10; Figure 7). Eight (8) samples exceeded the US EPA screening value for total PCBs (20 µg/kg), seven (7) of which were collected from the Escambia River or Escambia Bay. The other sample was collected in Bayou Chico, an industrial urban bayou. Four of the composite samples from the lower Escambia River exceeded the State of Florida threshold of 50 µg/kg (56.7-85.1 µg/kg). One composite sample was split into skin-on and skin-off fillets by taking one side of each of four (4) fish for either treatment. Leaving the skin on more than doubled the PCB content of the sample (23.5 to 54.6 µg/kg)

Of interest, only the mullet collected in the lower Escambia river and Escambia delta area had the highest PCB loads. These are highly mobile fishes with an annual spawning run out to the shelf break in the Gulf of Mexico. However, the highly contaminated specimens were from a relatively small spatial area. The contamination being absorbed by these fishes is not being spatially averaged by their mobility. Presumably the high and spatially explicit loads being absorbed by these fishes is a result of their sediment feeding habit and a long gut that would increase absorption efficiency. These factors may be combined with a heretofore unrecognized tendency to site fidelity when not making their spawning run.

Mullet samples from the I-10 Bridge in the middle of Escambia Bay had the highest levels of PCBs recorded for any fish species in the study (284-1580 µg/kg; Table 10; Figure 7). Levels of PCBs were 32 times the Florida screening value and 80 times the US EPA screening value. Construction activity on the bridge in 2006, including boat traffic and driving pilings into the bay bottom, may have disturbed PCB laden sediments resulting in a pulse of these compounds into the food webs and biota of the bay.

Mullet also had the highest levels of DF in the samples of all bass and mullet tested. Many of the mullet had DF levels over the US EPA TEQ screening value of 0.256 ng/kg, even with the co-planar PCBs not included. The highest recorded values were from the Escambia River (0.24-0.60 ng/kg) and Bayou Chico (0.23-0.75 ng/kg).

The data for striped mullet do not fit conventional ideas of bioaccumulation. As a relatively short-lived detritivore/algivore, this fish was hypothesized to have low levels of contaminants, but was included in our study because of the large quantities caught and consumed by humans (Tables 5 and 6). Consistent with the life history of the fish, relatively low levels of total Hg were found, but contrary to expectations, the highest levels of PCBs recorded in the study for any species were found in this organism (Figure 9). The highest levels of PCBs were found only at sites with known PCB contamination (Duke et al., 1970; Lewis et al., 2001). The long gut of this fish may account for a greater absorption of the compounds, and the restricted nature of the highly contaminated specimens suggests an unsuspected site fidelity for a highly mobile and migratory species that makes an annual spawning run offshore to the shelf break.

An analysis of homolog patterns within the biota sampled in this investigation is presented in Figure 9. The homolog patterns for the common commercial Aroclor preparations (PCB mixtures; data from: http://www.epa.gov/toxteam/pcbid/aroclor_comp.htm) are included as potential sources of contamination for comparison to the tissue profiles. The major known source of PCB contamination to the Escambia River and Escambia Bay was from a spill of Aroclor 1254. PCB homolog patterns in tissue from fish collected at the Escambia I-10 bridge samples cluster with the homolog fingerprint for this raw product (Aroclor 1254). This supports the idea that disturbance to the sediments has exposed biota to unweathered Aroclor 1254. Fish tissue samples from the rest of the Escambia Bay samples form a looser cluster with Aroclor 1254, suggesting attenuation through biotic transfers and partial degradation of the raw product. PCBs from fish tissue samples taken from the industrialized bayous (Chico and Grande) cluster with the Aroclor 1260 homolog pattern, suggesting either enrichment of more highly chlorinated homologs with partitioning into the biota, or an alternate source of PCBs. However, other sources of PCB contamination to the regional waterways are undocumented.

Table 10. Sampling and contaminant load data for mullet *Mugil cephalus* from NW Florida waters. Bold values exceed US EPA screening values for recreational fisher consumption.

| Location | Mean Length (mm) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg |
|---|---|---|---|---|---|---|---|
| Perdido River | 322 | 1.5 | 0.1450 | 0.0823 | 0.2273 | 3.843 | 0.021 |
| Perdido River | 310 | 1.7 | **0.3060** | 0.1674 | **0.4734** | 8.050 | 0.021 |
| Perdido River | 318 | 2.8 | **0.3800** | 0.1999 | **0.5799** | 8.087 | |
| Perdido River-Mid | 338 | 2.1 | 0.1240 | 0.1078 | 0.2318 | 5.283 | |
| Perdido River-Mid | 320 | 1.0 | 0.1130 | 0.0982 | 0.2112 | 3.110 | 0.010 |
| Perdido River-Mid | 321 | 1.3 | 0.1630 | 0.0090 | 0.1720 | 6.363 | 0.010 |
| 11 Mile Creek | 329 | 2.1 | **0.3490** | **0.2913** | **0.6403** | 12.400 | 0.018 |
| 11 Mile Creek | 314 | 2.1 | **0.3270** | **0.2712** | **0.5982** | **21.188** | |
| 11 Mile Creek | 382 | 1.5 | 0.1480 | 0.1717 | **0.3197** | 14.027 | 0.018 |
| Bayou Chico | 312 | | **0.3420** | **0.5009** | **0.8429** | **21.269** | |
| Bayou Chico | 326 | 1.1 | **0.6560** | **1.1278** | **1.7838** | **40.800** | |
| Bayou Chico | 314 | 0.4 | **1.2398** | **0.9612** | **2.2010** | **29.392** | 0.008 |
| Bayou Grande | 314 | 0.3 | **0.5299** | **0.3020** | **0.8319** | 14.500 | 0.008 |
| Bayou Grande | 358 | 0.5 | **0.1230** | **0.5139** | **0.6369** | **20.351** | |
| Bayou Grande | 344 | 0.9 | **0.3600** | **0.5792** | **0.9392** | **22.103** | 0.008 |
| Bayou Texar | 390 | 1.3 | **1.1360** | **0.3630** | **1.4990** | **21.500** | 0.010 |
| Bayou Texar | 373 | 1.0 | 0.0110 | 0.0219 | 0.0329 | 9.859 | |
| Bayou Texar | 385 | 0.5 | 0.0840 | 0.2389 | **0.3229** | 14.113 | 0.010 |
| Hoffman Woodland Bayou | 374 | 0.8 | **0.5920** | 0.1312 | **0.7232** | 6.300 | 0.014 |
| Hoffman Woodland Bayou | 384 | 0.7 | **0.3230** | 0.1546 | **0.4776** | 8.310 | 0.014 |
| Hoffman-Woodland Bayous | 311 | 4.8 | **0.5510** | **0.3975** | **0.9485** | 19.000 | 0.027 |
| Yellow River Lower | 355 | 1.0 | 0.0000 | 0.0038 | 0.0038 | 2.080 | |
| Yellow River Lower | 394 | 1.3 | 0.1280 | 0.0721 | 0.2001 | 4.517 | |
| Yellow River Lower | 342 | 1.4 | 0.2170 | 0.1209 | **0.3379** | 5.050 | 0.012 |
| East Bay | 419 | 1.1 | 0.0000 | 0.2119 | 0.2119 | 5.800 | 0.026 |
| East Bay | 422 | 2.8 | 0.0350 | 0.0564 | 0.0914 | 13.100 | |
| East Bay | 434 | 0.6 | 0.0980 | 0.0203 | 0.1183 | 7.759 | 0.026 |
| Escambia River Rt 4 Bridge | 353 | 4.7 | **0.7760** | 0.2420 | **1.0180** | **29.800** | 0.021 |
| Escambia River Rt 4 Bridge | 199 | 0.9 | **0.5365** | 0.0253 | **0.5618** | 4.390 | 0.008 |
| Escambia River Rt 4 Bridge | 295 | 3.2 | 0.1655 | **0.4048** | **0.5703** | **42.600** | 0.017 |

Table 10. continued. Sampling and contaminant load data for mullet *Mugil cephalus* from Escambia Bay and River, NW Florida. Bold values exceed US EPA screening values for recreational fisher consumption

| Location | Mean Length (mm) | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg |
|---|---|---|---|---|---|---|---|
| Escambia River Quintette Bridge | 346 | 1.0 | **0.3990** | 0.1675 | **0.5665** | 18.600 | |
| Escambia River Quintette Bridge | 390 | 2.8 | **1.6293** | **0.5613** | **2.1906** | **33.300** | |
| Escambia River Quintette Bridge | 430 | 3.6 | **1.4059** | 0.0410 | **1.4469** | **32.100** | |
| Escambia River Quintette Bridge | 455 | 1.1 | **0.9838** | 0.2267 | **1.2105** | **20.400** | |
| Escambia River-Above Mansanto | 450 | 6.5 | **0.5750** | **0.3556** | **0.9306** | **22.480** | |
| Escambia River Crist Plant | 316 | 1.1 | 0.0910 | **0.3508** | **0.4418** | **39.000** | |
| Escambia River Crist Plant | 350 | 1.0 | 0.2160 | **0.7479** | **0.9639** | **57.700** | |
| Escambia River Crist Plant | 385 | 1.2 | **1.0959** | **1.2081** | **2.3040** | **85.100** | |
| Escambia River Crist Plant | 457 | 1.7 | **0.5802** | **0.8412** | **1.4214** | **56.700** | |
| Escambia River, Lower | 381 | 2.0 | **0.3750** | 0.0577 | **0.4327** | **24.852** | |
| Escambia River, Lower | 402 | 1.9 | **0.4420** | **0.9390** | **1.3810** | **84.000** | 0.017 |
| Escambia River, Lower | 388 | 2.2 | 0.0480 | **0.5199** | **0.5679** | **48.605** | 0.017 |
| Escambia Bay NW, *Mullet Fillet only, split sample with below* | 314 | 2.0 | | **1.5337** | | **23.457** | 0.010 |
| Escambia Bay NW, *Mullet Fillet w/Skin, split sample with above* | 314 | 4.7 | | **0.5732** | | **54.620** | 0.011 |
| Escambia Bay NE | 424 | 2.1 | 0.0670 | 0.0662 | 0.1332 | **33.600** | |
| Escambia Bay NE | 387 | 1.1 | **0.3030** | 0.0834 | **0.3864** | **36.724** | |
| Escambia Bay NE | 388 | 1.7 | 0.1640 | **0.7789** | **0.9429** | **24.600** | 0.018 |
| Escambia Bay SE | 392 | 0.6 | **0.3630** | 0.2393 | **0.6023** | 8.570 | 0.014 |
| Escambia Bay SE | 401 | 0.7 | 0.0463 | **0.2750** | **0.3213** | 9.140 | 0.021 |
| Escambia Bay SW | 387 | 1.9 | **0.4930** | 0.0787 | **0.5717** | **38.699** | |
| Escambia Bay SW | 395 | 1.3 | 0.0310 | **0.4469** | **0.4779** | **21.200** | |
| Escambia Bay SW | 417 | 1.4 | 0.1490 | **0.3064** | **0.4554** | **20.100** | 0.024 |
| Escambia Bay I-10 Bridge | 450 | 3.9 | **0.4382** | **12.161** | **12.5992** | **284.000** | 0.013 |
| Escambia Bay I-10 Bridge | 470 | 3.3 | **0.4668** | **68.508** | **68.9743** | **1580.000** | 0.010 |
| Escambia Bay I-10 Bridge | 424 | 2.2 | **0.5219** | **39.587** | **40.1086** | **1003.260** | 0.011 |
| Escambia Bay I-10 Bridge | 408 | 4.4 | **1.0701** | **19.610** | **20.6803** | **678.000** | 0.010 |

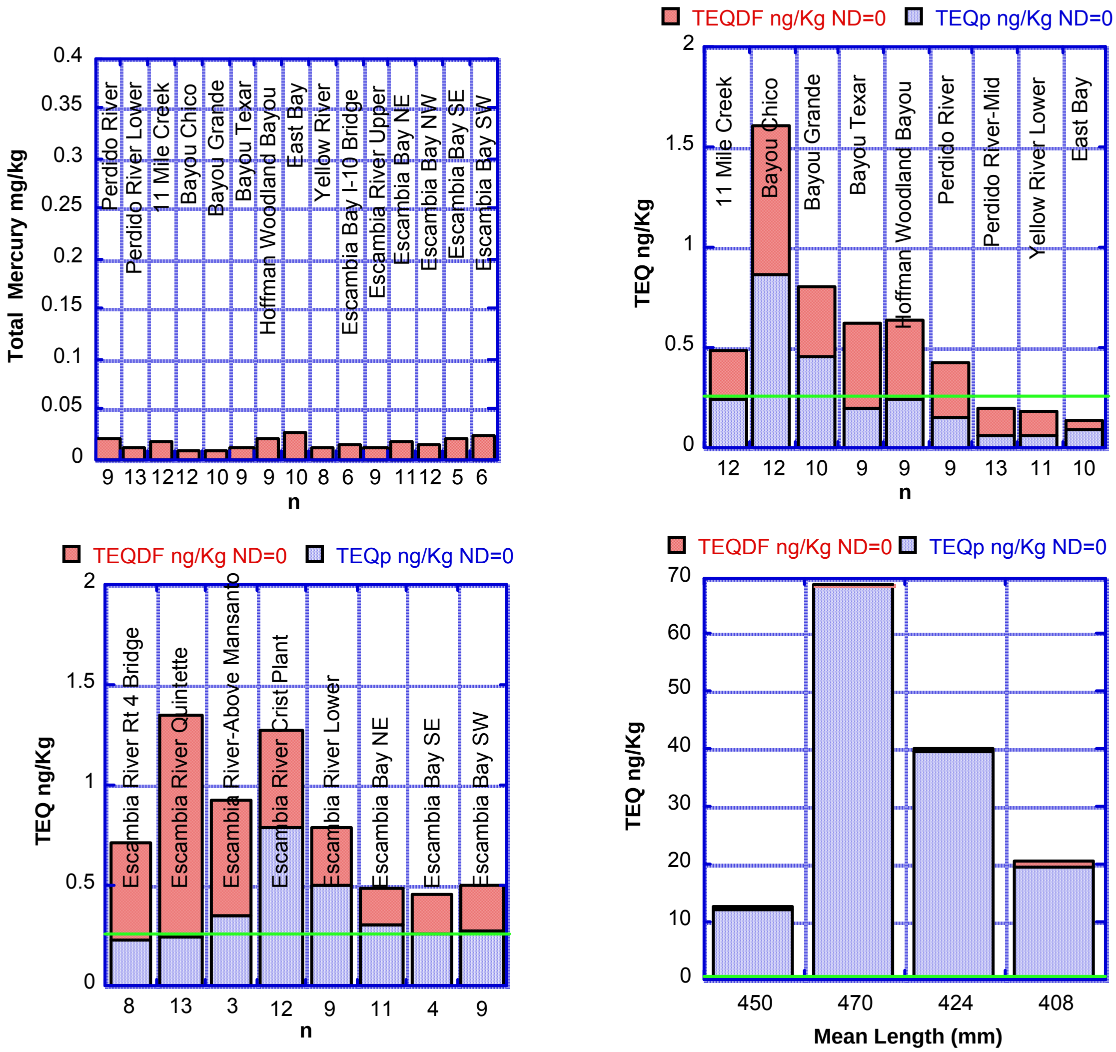



Figure 7. Contaminant loads in striped mullet in NW Florida waters. Green lines represent the US EPA screening values for recreational fisher consumption. US EPA Hg screening value for recreational fisher consumption is 0.4 mg/kg. “n” = number of fish per average. Data presented in the bottom right graph are for individual fish collected at the Escambia Bay I-10 Bridge. Note the change of TEQ scale for this graph.

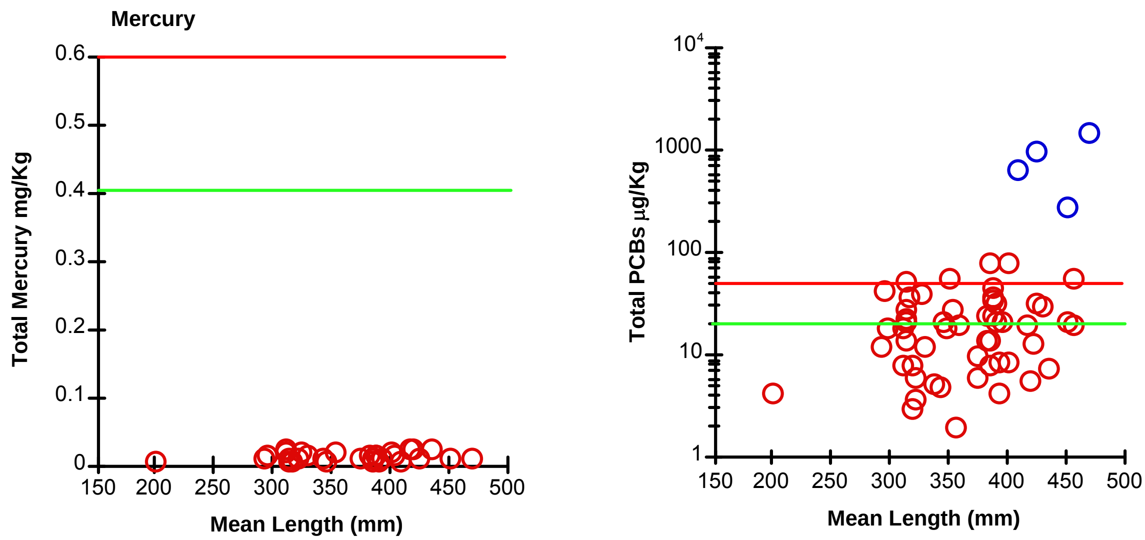



Figure 8. Total mercury (left) and total PCBs (right) loads in Striped Mullet, *Mugil cephalus*. Note log scale on the PCB content graph. Specimens denoted by blue circles were collected at the Escambia Bay I-10 bridge site after two years of submarine construction activity. Green lines represent US EPA thresholds for recreational fisher consumption advisories, Red lines represent State of Florida thresholds.

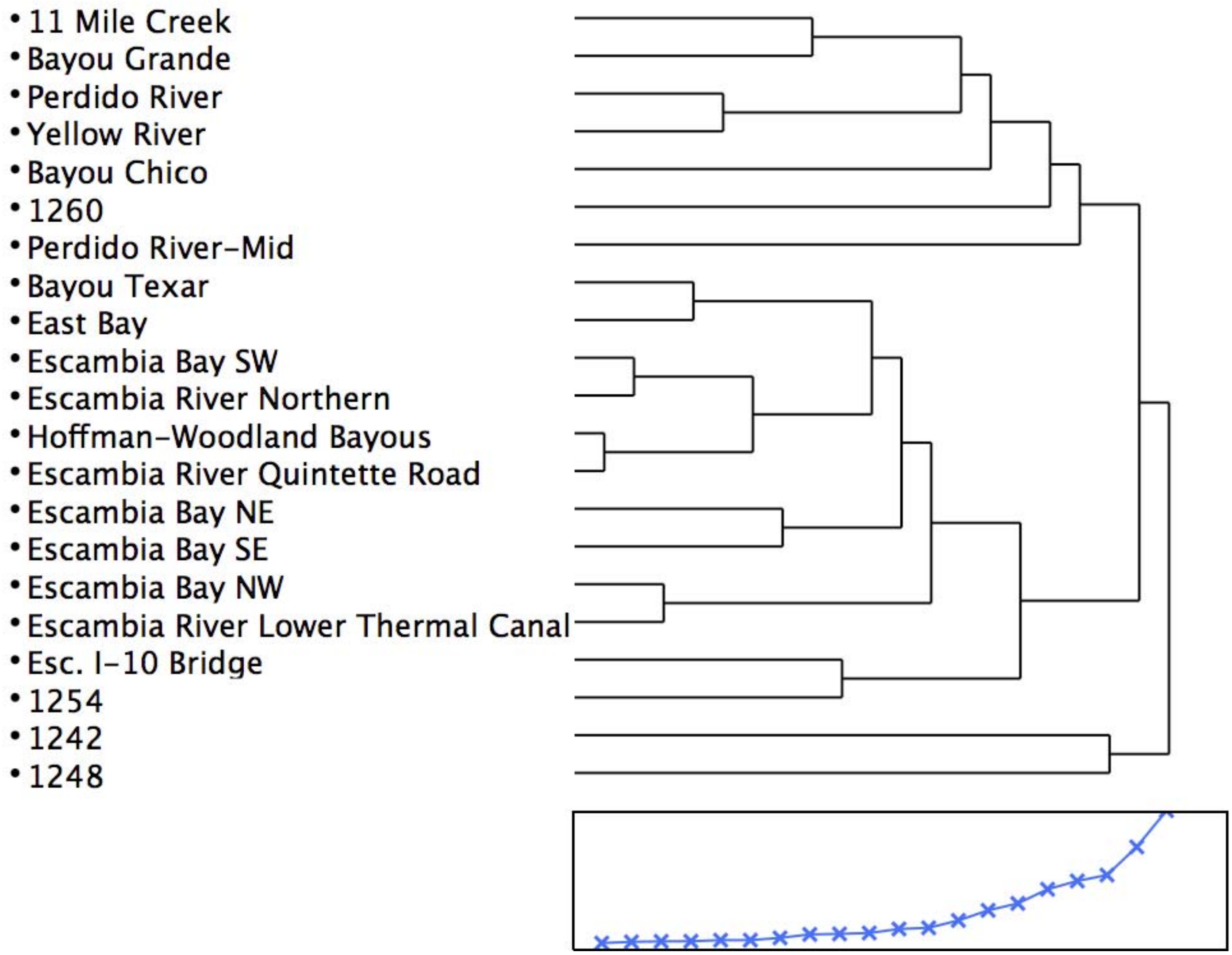



Figure 9. PCB homolog "fingerprints" from mullet fillets used in cluster analysis. Numbers refer to commercial Aroclor mixtures as potential sources of the contamination. Note the close relationship of the I-10 bridge samples with Aroclor 1254.

## III. Patterns of mercury and polychlorinated biphenyl concentrations in estuarine and marine fishes of northwest Florida and the Northern Gulf of Mexico.

### A. *Materials and Methods*

Seventeen zones within Pensacola Bay and Perdido Bay watersheds (Figure 10) have been targeted during this study, in addition to fishes from the offshore environment. Sampling procedures followed methods prescribed by the US in *Guidance for assessing chemical contaminant data for use in fish advisories: fish sampling and analysis* (US EPA, 2000). Date and time of sampling and fish length were recorded in the field, and multiple specimens were sorted into similar-sized composite samples. Specimens were wrapped in foil and placed in sealed plastic bags with identification labels on ice for transport to the laboratory for processing. In the laboratory, fish were re-measured and weighed. All processing equipment was washed in mild soapy water, rinsed in a sequence of hot tap water, ethanol or propanol, and purified water. Foil sheets were used to cover cutting boards and handle fillets. Stainless steel fillet knives were used to collect bone and skin-free samples. Total fillet weight was recorded, tissues were mascerated in a Foss Tecator tissue homgenizer, and the weight of homogenized tissue added to certified, clean sample jars (500 ml) was recorded. Left and right sagittal otoliths were preserved from all fish within each composite. Otoliths were sectioned and aged to develop potential age, length and contaminant load correlations in marine fish tissues

Tissue samples were kept frozen until transport on ice to Pace Analytical Laboratories, MN for analysis of organics: Dioxins-Furans (DF), Polychlorinated Biphenyls (PCBs), and metals: mercury (Hg), Arsenic (As), Inorganic Arsenic (In. As). Toxic equivalent quotients (TEQ) were calculated for DF ($TEQ_{DF}$), Dioxin-like co-planer PCBs ($TEQ_P$), and combined DF and Dioxin-like PCBs ($TEQ_{DFP}$) using the updated TEF values presented in Van den Berg et al. (2006).

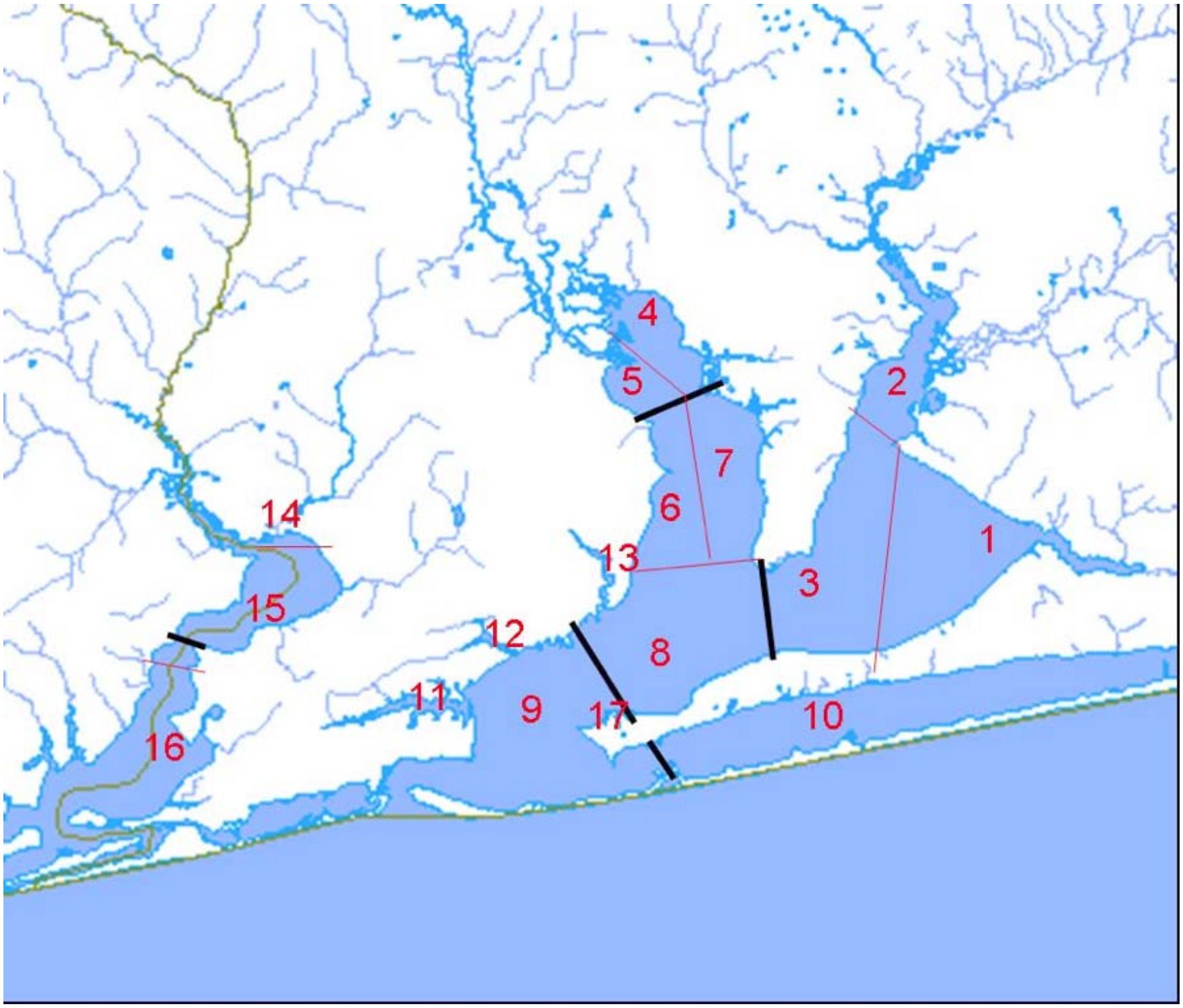


Figure 10. Finfish sampling zones in Blackwater, East, Escambia, Pensacola and Perdido Bays.

**B. *Results and Discussion***

Data were recorded for 1199 specimens within 48 species. Individual species information and tabular data are included as Appendix I. These pages will be established as a series of web pages and made available as a hard copy guide for local fishermen and seafood consumers.

Based on contaminant analysis of Blue Crab, American Oyster, and Mullet, Blackwater-East Bays (zones1-3), lower Pensacola Bay (zone 9), Santa Rosa Sound (zone 10, and Perdido Bay (zones 15-16) may be considered "green areas". Most fish sampled from these areas had contaminants below US EPA screening values for DF, PCBs, and Hg (US EPA, 2000). However, with many of the other finfish that are highly mobile and of relatively high trophic status (Table 10), these patterns tend to be blurred. For example, large red drum caught in East Bay and Santa Rosa Sound, the cleanest zones in the region, had the highest PCB loads recorded for this species (60.3 and 40.3 ng/kg respectively).

While most species bioaccumulate DF, PCBs and Hg with age, there are some notable exceptions. Spotted (or speckled) seatrout and Spanish mackerel, *Scomberomorous maculatus*, show classic bioaccumulation in individuals for Hg. However, a reverse pattern is seen for PCBs (Figures 11, 12, 13), reflecting exposure to diffuse distribution of Hg in the environment but a relatively restricted distribution of highly contaminated PCB sites. Some of this may be explained by ontogenic shifts in habitat use and prey preferences as the fish becomes less dependent with age on estuarine resources where contamination is high. In contrast, the data for king mackerel, *Scomberomorus cavalla*, shows bioaccumulation for both compounds and tomuch higher levels (Figure 13). The higher Hg content in large specimens of these fishes has been well documented. The accumulation of high PCB loads was not. The highly migratory nature of these fishes with varying degrees of estuarine utilization as summer foraging areas likely contributes to the variability seen in the data. Our Hg data for spotted seatrout tends to agree with the trends of previously reported data (Figure 12; Rider and Adams, 2000), but also adds greater definition of Hg dynamics in this species.

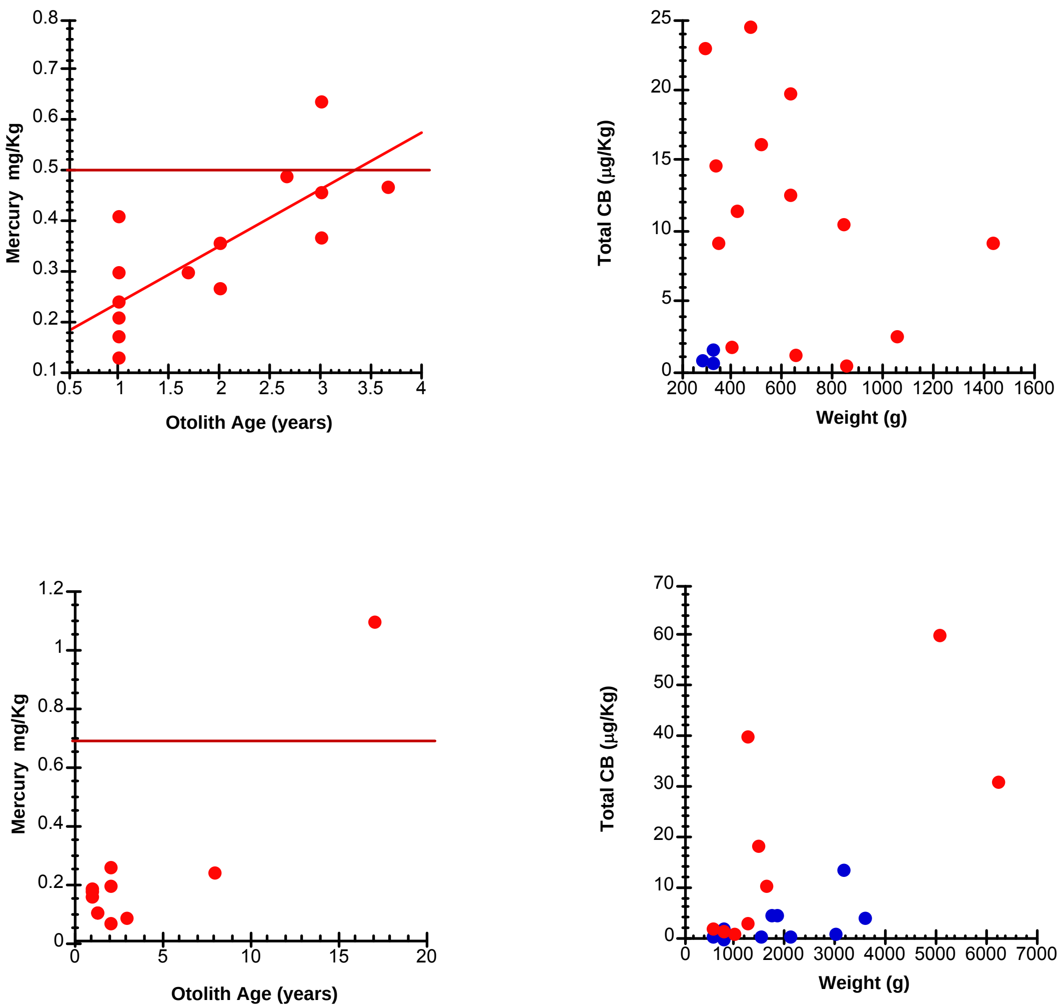



Figure 11. Mercury (left column) and total PCBs (right column) for spotted trout (top row) and red drum (bottom row). Red symbols are from this study. Blue symbols are from Indian River lagoon for comparison (Johnson-Restrepo et al., 2005; Table 11).

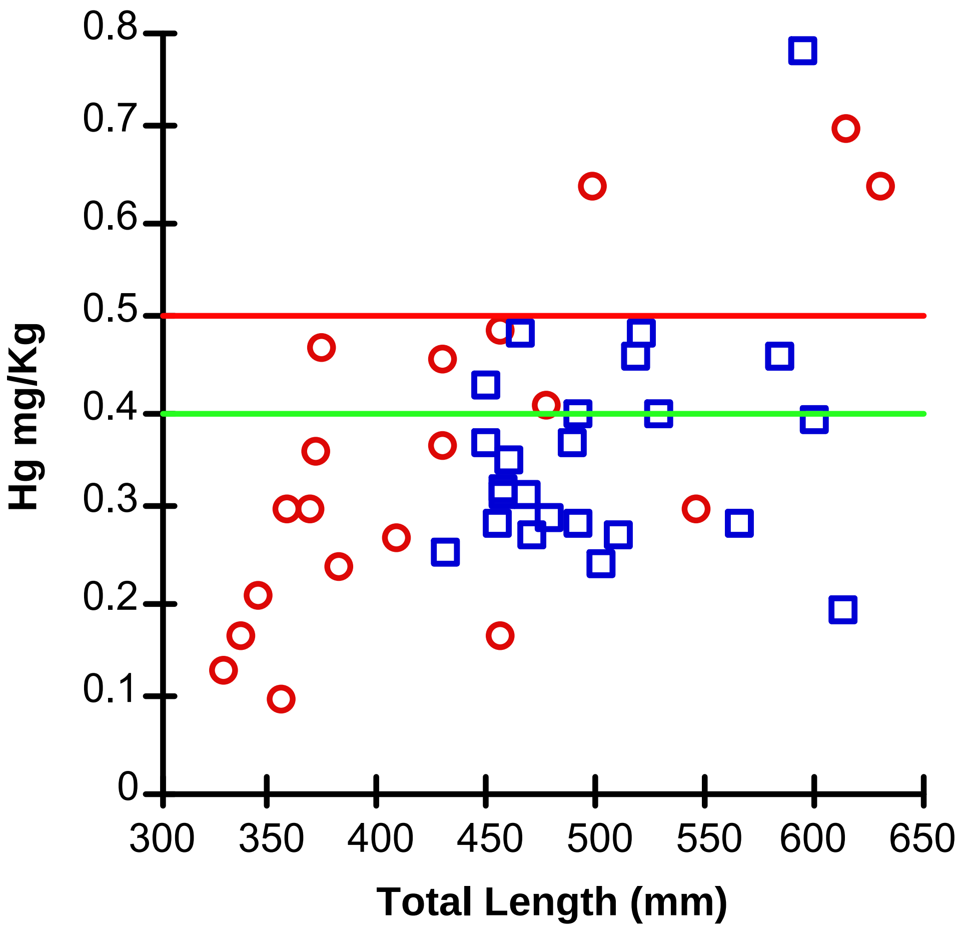



Figure 12. Mercury content in spotted seatrout, *Cynoscion nebulosus*, in the Pensacola Bay system. Blue squares are data reported by Rider and Adams (2000). Red circles are data collected in this study. The green line represents the US EPA recreational screening value. The red line represents the State of Florida threshold for limited consumption advisories.

Fish consumption advisories currently exist for mercury in fish from most statewide fresh waters and for several marine species (http://dep.state.fl.us/floridafishadvice/). Our work in the Pensacola Bay System, including the freshwater drainages, has resulted in Florida Department of Health (DOH) recognizing that serious PCB problems exist in the Pensacola Bay System. We have documented high levels of PCBs and $TEQ_{DFP}$ despite the last known spill of PCBs having occurred over 35 years ago. During the course of our study, a smaller scale study was published from samples collected in Indian River Lagoon, on the Atlantic coast of Florida (Johnson-Restrepo et al., 2005). Three species of fish were common to both studies and provide a basis for comparison (Table 4.). The lowest recorded concentrations of PCBs for striped mullet, spotted seatrout, and red drum are similar between these systems. Average total PCB tissue concentrations were 17, 7, and 2 times higher for these species, respectively, in the Pensacola Bay System than on the Atlantic coast in Indian River Lagoon. Included in the average values for Pensacola were samples from relatively clean and green areas. The maximum PCB values highlight the contamination in Escambia Bay, with values 126, 41 and 2 times higher for striped mullet, spotted seatrout, and red drum in the Pensacola Bay system. By extension, the extraordinary PCB concentrations in elasmobranchs from Indian River which have a higher tropic level status, longer life span, and high lipid content, raise concern for similar species in the northern Gulf of Mexico.

In the higher salinity waters of estuaries and out into coastal waters of Florida, assumptions that levels of contamination in the marine environment would begin to decrease with the end of production and use of PCBs, have not been validated. Indeed, evidence to the contrary has indicated that PCB levels may be substantially higher now in Bull sharks and Bottlenose dolphins than they were a decade ago (Table 11).

Table 11. PCB levels recorded in a food web study of estuarine and coastal species, Atlantic and Gulf Coasts of Florida (from Johnson-Restrepo et al., 2005). PCB body burdens in general reflect trophic status of these organisms. All species were recovered from Indian River Estuary or nearby coastal waters except where noted for bottlenose dolphins. PCB levels are for muscle tissue except dolphins, where blubber samples from stranded animals were processed.

| | | Indian River* | | | Pensacola Bay** | | |
|---|---|---|---|---|---|---|---|
| **Common name** | **species** | **Average PCBs ng/g tissue** | **Minimum PCBs ng/g tissue** | **Maximum PCBs ng/g tissue** | **Average PCBs ng/g tissue** | **Minimum PCBs ng/g tissue** | **Maximum PCBs ng/g tissue** |
| Silver Perch | *Bairdiella chrysoura* | 1.56 | 0.44 | 3.776 | | | |
| Striped Mullet | *Mugil cephalus* | 5.192 | 1.892 | 12.54 | 86.772 | 2.08 | 1580 |
| Atlantic Stingrays | *Dasyatis sabina* | 2.96 | 0.34 | 1.58 | | | |
| Spiny Dogfish | *Squalos acanthias* | 79 | 60.5 | 98 | | | |
| Hardhead Catfish | *Arius felis* | 8.352 | 1.161 | 36.99 | | | |
| Spotted Seatrout | *Cynoscion nebulosus* | 3.42 | 0.585 | 5.13 | 23.0 | 0.5 | 209.325 |
| Red Drum | *Sciaenops ocellatus* | 8.67 | 0.156 | 41.4 | 16.3 | 0.916 | 60.322 |
| Atlantic Sharpnosed shark | *Rhizoprionodon terraenovae* | 22.08 | 0.004 | 3.08 | | | |
| Bull Shark 1993-1994 | *Carcharinus leucas* | 38.64 | 23.58 | 49.86 | | | |
| Bull Shark 2002-2004 | *Carcharinus leucas* | 284.8 | 11.72 | 1308 | | | |
| Bottlenose Dolphins West coast Fl 1991-1996 | *Tursiops truncatus* | 13213 | 2292.2 | 40150 | | | |
| Bottlenose Dolphins West coast Fl 2000-2004 | *Tursiops truncatus* | 93600 | 3857.1 | 436800 | | | |

*calculated from PCBs ng/g lipid and % lipid values in Johnson-Restrepo et al., 2005.
**this study.

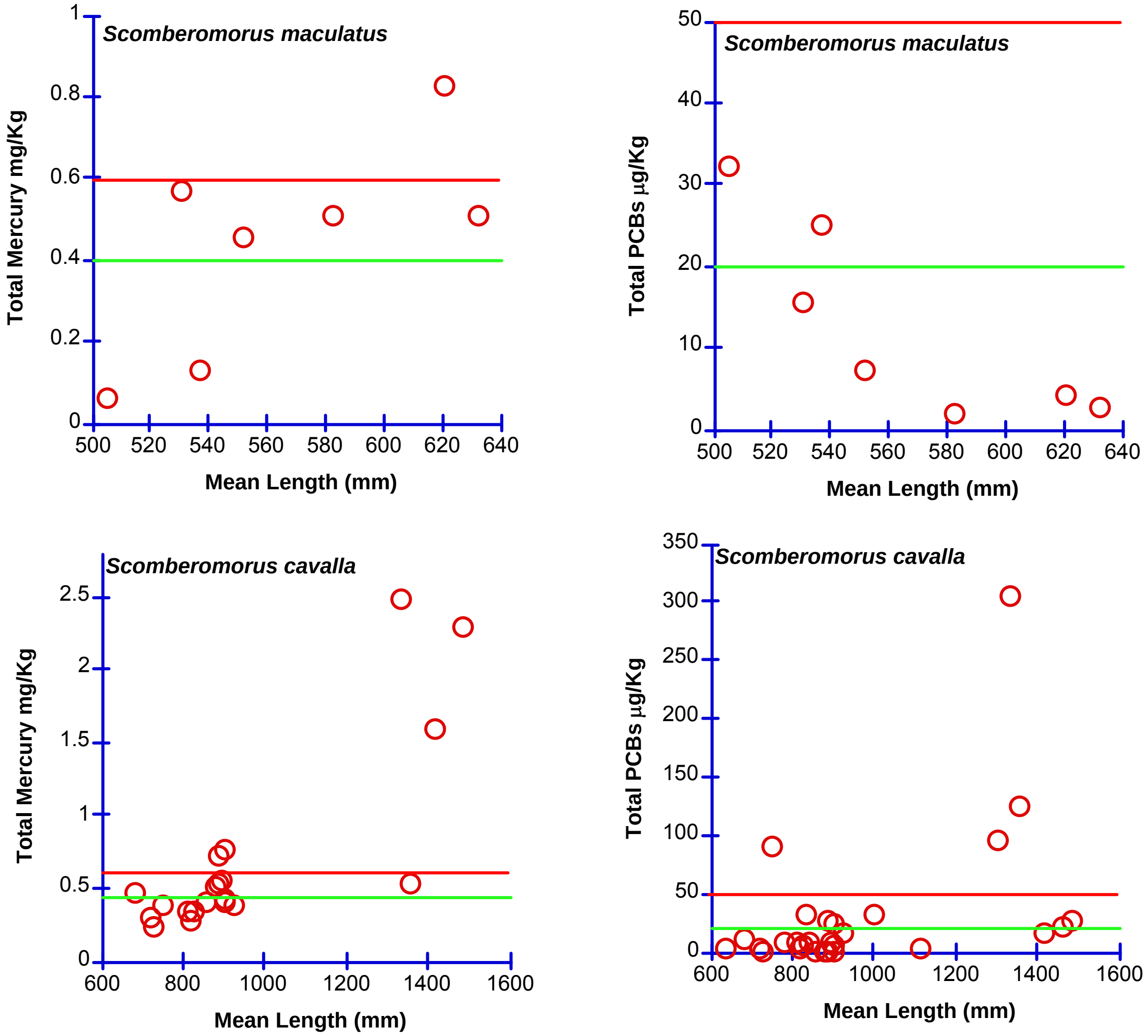



Figure 13. Concentrations of total mercury (left) and total PCBs (right) in Spanish mackerel, *Scomberomorus maculatus* (top) and king mackerel, *Scomberomorous cavalla* (bottom). Green lines represent US EPA thresholds for recreational fisher consumption advisories, Red lines represent State of Florida thresholds. Note differences in the contaminant concentration scales between these two species.

The high concentrations of PCBs in mullet, which make an annual spawning run offshore, has brought to light a major yet relatively unrecognized flux of these persistent bioaccumulative contaminants from inshore contaminated sites to the offshore shelf environment. Many of the widely harvested predatory fish species, and their prey, make either an annual migration or an ontogenic shift from inshore to offshore, carrying toxic compounds absorbed in the estuaries and closer to the coast to the offshore shelf environment. This inshore to offshore transport is not well documented, yet highly contaminated inland sites around the Gulf Coast (Rosales et al., 1979; Howell et al, 2007; Harvey et al., 2008) may be contributing to offshore contamination via abundant and migratory species like mullet.

While Hg concentrations in offshore fisheries have been examined for some species, the Hg loads for many species are unknown.  PCB loads in marine fishes across the Gulf of Mexico are less well known, although high body burdens in estuarine fishes around the Gulf Coast have been documented (Harvey et al., 2009).  This indicates inshore sources have the potential for offshore transport and accumulation in marine species. Relatively high levels of PCBs were found in Croaker (*Micropogonias undulates)* from limited sampling of fishes offshore of the Mississippi delta following Hurricane Katrina (Krahn et al., 2005), though the authors concluded that no significant health risk for PCBs existed. For several grouper species in our study, the concentrations of mercury and PCBs appeared to correlate with size/age with some samples exceeding the US EPA screening threshold for total PCBs (Figure 14).

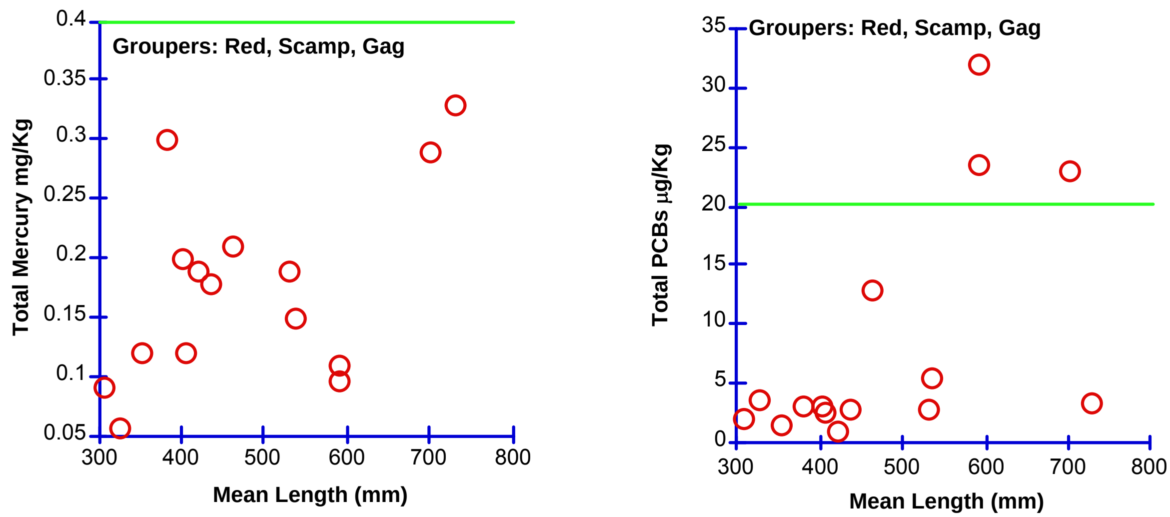



Figure 14.  Total mercury (left) and total PCBs (right) loads in Groupers: *Epinephelus morio* (Red), *Mycteroperca microlepis* (Gag), *Mycteroperca phenax* (Scamp). The green lines represent US EPA thresholds for recreational fisher consumption advisories, Red lines represent State of Florida thresholds.

Red snapper (*Lutjanus campechensus*), a signature offshore reef fish of the Gulf of Mexico that is targeted by both commercial and recreational fisheries, also show bioaccumulation of PCBs and mercury with increasing size, with a few samples suggesting that a further gulf-wide investigation of toxin loads in offshore fishes may be warranted (Figure 15).

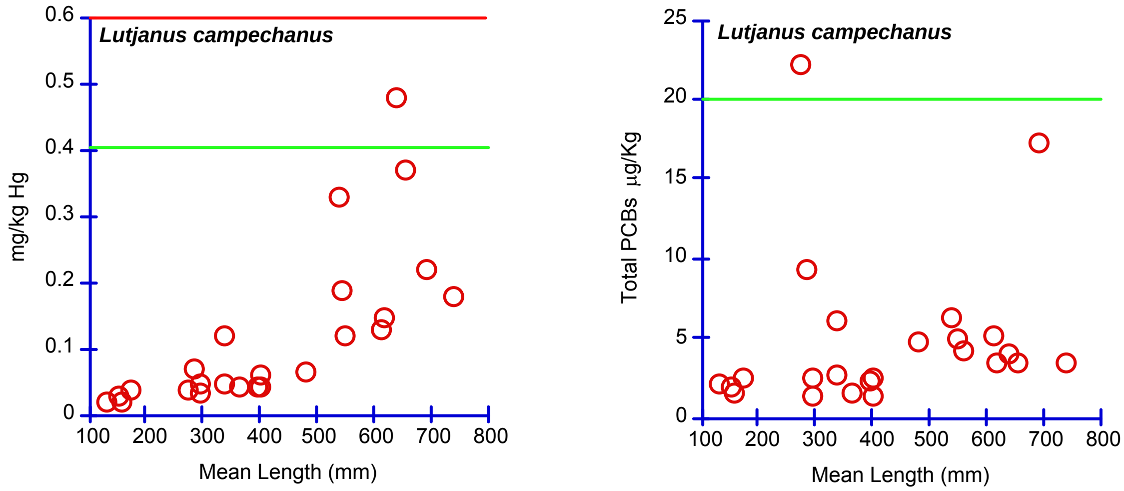



Figure 15. Total mercury (left) and total PCBs (right) loads in red snapper, *Lutjanus campechanus*. The green lines represent US EPA thresholds for recreational fisher consumption. The red lines represent State of Florida thresholds.

***i. Partitioning of PCB congeners in biota from previous studies.***

Mobility of the PCB molecules, their biodegradation, and overall bioavailability are relatively selective processes that affect the appearance of congeners in the tissues of biota relative to the source materials. Partitioning into biota represents a balance of bioavailability via largely aqueous media and the preferential absorption and accumulation in lipids with age and by trophic transfers. For example, oysters have been found to accumulate lower chlorinated PCBs relative to sediment loads (Wade et al., 1988), reflecting their exposure via filtering of water, where higher chlorinated congeners may be underrepresented. A study of a highly chlorinated PCB (1268) source (Kannan et al., 1998) found biota accumulating a predominance of more highly chlorinated congeners, and the proportions of these homologs were correlated to the source material. Despite high octanol-water partitioning ($K_{ow}$) coefficients, highly chlorinated PCBs were not bioaccumulated as much as expected, and it was speculated that steric factors (molecular size) and bioavailabilty (extreme hydrophobicity) may have limited their uptake (Kannan et al., 1998).

***ii. PCB Homolog Patterns in the current study.***

In our study, the most highly contaminated fish samples from the known contaminated area of Escambia Bay also correlated with homolog proportions of the source material, though samples at greater distance reflect more partitioning and attenuation, presumably by biological transport and food web partitioning. Homolog patterns within the biota sampled in this investigation are presented in Figure 16 for offshore, estuarine, and fish samples taken at the site of the I-10 bridge blast in Escambia Bay. The homolog patterns for the common commercial Aroclor preparations were plotted with data from http://www.epa.gov/toxteam/pcbid/aroclor_comp.htm for comparison to the tissue profiles.

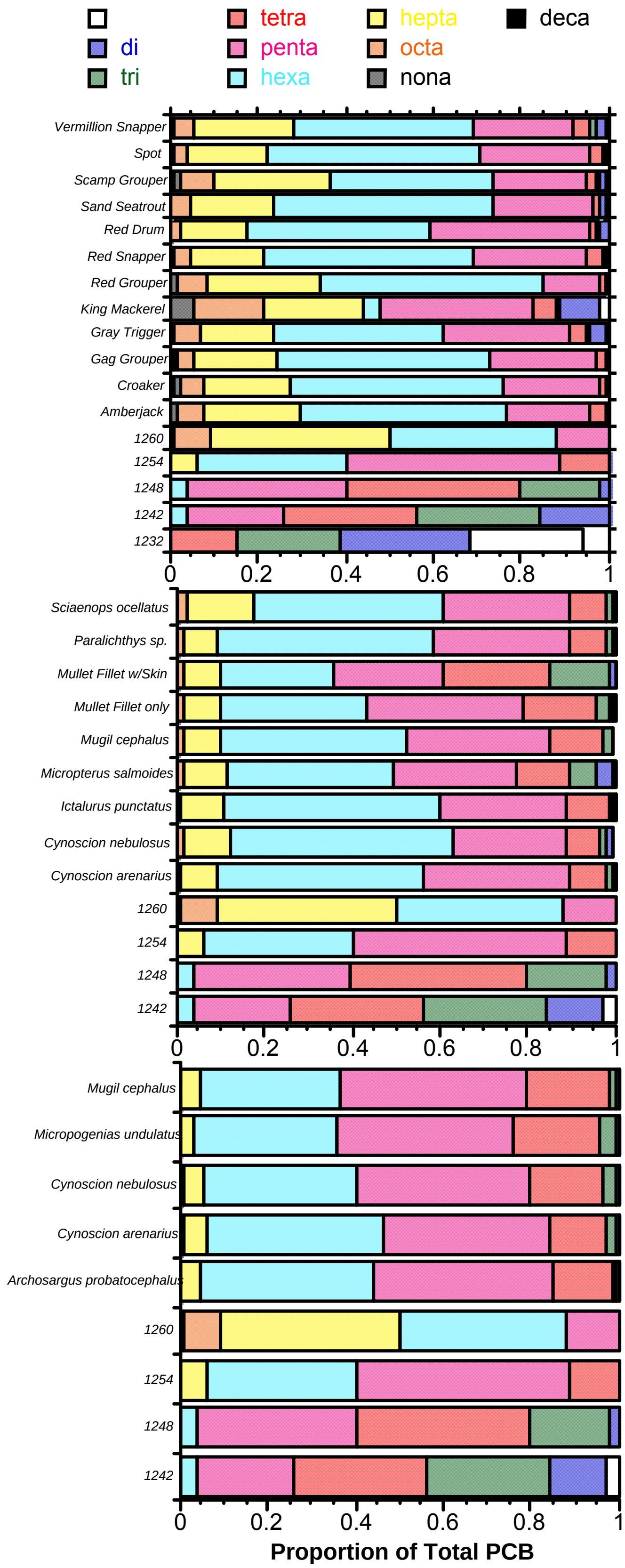



Figure 16. Averaged PCB homolog proportions in offshore (top) and estuarine (middle) fish samples and those collected after the demolition blast at the I-10 bridge in Escambia Bay (bottom). Numbers refer to commercial Aroclor preparations.

As with the mullet samples (Figure 9), other fish specimens sampled at the Escambia Bay I-10 bridge blast site have a PCB homolog pattern with strong similarity to Aroclor 1254 (Figure 16, bottom), the source material for contamination in the Escambia River and Bay. All other PCB data from fish samples in the estuary, which include the previously sampled Escambia Bay and Escambia River fishes, show a moderate affinity to the 1254 pattern, but have enriched hepta- and octa-chlorinated homologs. This may reflect the biological partitioning and the weathering and degradation of the less chlorinated congeners. In the case of Bayou Chico, contamination from other sources of industrial Aroclor use is likely, in addition to biological partitioning and degradation.

Of interest are the paired skinned and skinless mullet fillets from the Escambia River delta (Figure 16, middle). The composite with fillet plus skin had roughly double the total PCB content and was more highly enriched in tri-chlorinated congeners than the skinless fillet composite. An opposite pattern is seen for the TEQ values. The TEQ value for the skin-on sample was one third the TEQ value of the skinless fillets (ND = 0 TEQ 0.573 versus 1.534 ng/kg; Table 10). These results indicate a partitioning of not only more highly chlorinated congeners (penta- and hexa-) in the muscle tissue, but the more toxic ones as well.

Moving further away from direct contamination sources, the offshore fish samples show further attenuation of lesser chlorinated congeners and enrichment in the more highly chlorinated ones Figure 16, top). This pattern shift is consistent with differential partitioning in food webs and the biological dispersal of PCBs from the inshore environment to offshore.

## IV. Perspectives

Atmospheric deposition of mercury to the Pensacola Bay watershed is the likely source of contamination leading to elevated levels of mercury in fish in the area wasters. There are exceptions, such as the spring-fed Woodbine Lake, in which a geological source seems to contribute excessive amounts of mercury. Although consumption advisories based on mercury loads have been issued by Florida DOH throughout the state, there has been relatively very little attention to systematically survey and issue fish consumption advisories based on other contaminants. We have shown that as a result of past discharges there are elevated levels of PCBs in various water bodies of the Pensacola Bay System leading to bioaccumulation in fish/shellfish tissues, in some cases reaching high enough levels posing potential cancer and non-cancer health risks. Our findings have in part aided the Florida DOH to issue fish consumption advisory for the lower Escambia River and Escambia Bay. It should be noted that elevated PCB loads are also found in fish/shellfish from other components of the Pensacola Bay System, especially the urban bayous in the area, areas for which no consumption advisories currently exist. In an unprecedented survey of seafood species for Dioxin/Furan content, we have shown that TEQs due to dioxins/furans and dioxin-like PCBs are elevated in fish/shellfish throughout the Pensacola Bay System, and also in several of the near-shore and offshore fishes. Florida DOH has not issued a State-wide screening level for TEQs. The transfer of persistent pollutants (Dioxins/Furans, PCBs, and *methyl*-mercury) within food webs is well known, but our data show other factors may negate accepted hypotheses concerning bioaccumulation. In addition, transfer of these compounds spatially in biota is rarely addressed, and this investigation has demonstrated a significant potential for dispersal via biota, especially from inshore contaminated areas to the offshore environment.

## V. Acknowledgements

This investigation is part of a project, assessment of Environmental Pollution and Community Health in Northwest Florida, supported by the US EPA cooperative agreement X-97455002 awarded to the University of West Florida (Project Director, K. Ranga Rao). The contents of this report are the sole responsibility of the authors and do not represent the views of the US EPA.

While the authors take responsibility for the contents, we cannot take full credit for the work. Florida Fish and Wildlife Conservation Commission (FWCC) provided a special activity license for the collections, and the FWCC personnel at the Holt Hatchery provided able assistance and expertise with electrofish sampling in freshwaters, provided mercury data for the bass collected from the regional river systems, and provided fish specimens recovered from the I-10 Escambia Bay bridge demolition work. We are grateful for the advice, cooperation, and assistance of local commercial and recreational fishermen. Sample data included in this report from the ex-Oriskany study were obtained by William Patterson and Richard Snyder, UWF (http://www.uwf.edu/rsnyder/reports/Oriskrpt.pdf) for the US Navy. Largemouth bass data collected from ponds in NW Florida was collected with funding from the Centers for Disease Control and Prevention (http://uwf.edu/cedb/PERCH_CDC_Final_Report_2007.pdf). The work could not have been accomplished without a small army of students and staff at the UWF, including Suzanne Gibson, Matthew Wagner, Jeffrey Allison, and Alexander Ren.

## VI. References Cited

Adams, D.H. and R.H. McMichael, Jr. 2001. *Mercury levels in marine and estuarine fishes of Florida*. Florida Marine Research Institute Technical Report TR-6. 35 pp.

Aguirre, A.L.I. and M. Gallardo-Cabello. 2004. Reproduction of *Mugil cephalus* and *M. curema* (Pisces: Mugilidae) from a coastal lagoon in the Gulf of Mexico. *Bulletin of Marine Science* 75:37-49.

Ahrenstorff, T.D., G.G. Sass, and M.R. Helmus. 2009. The influence of littoral zone coarse woody habitat on home range size, spatial distribution, and feeding ecology of largemouth bass (*Micropterus salmoides*). *Hydrobiologia* 623:223-233.

Akin, S. and K.O. Winemiller. 2008. Body size and trophic position in a temperate estuarine food web. *Acta Oecologia* 33:144-153.

Alam, S.K. and M.S. Brim. 2000. Organochlorine, PCB, PAH, and metal concentrations in eggs of loggerhead sea turtles (*Caretta caretta*) from northwest Florida, USA. *Journal of Environmental Science and Health. Part. B, Pesticides, food contaminants, and agricultural wastes*. 35(6):705-724.

Baird, R.C., N.P. Thompson, T.L. Hopkins, and W.R. Weiss. 1975. Chlorinated hydrocarbons in mesopelagic fishes of the Eastern Gulf of Mexico. *Bull. Mar. Sci*. 24:473-481.

Connor, K.T., M. Eversen, S.H. Su, and B.L. Finley. 2005. Quantitation of polychlorinated biphenyls in fish for human cancer risk assessment: a comparative case study. *Environmental Toxicity and Chemistry* 24:17-24.

De Silva, S.S. 1980. Biology of juvenile grey mullet: a short review. *Aquaculture* 19:21-36.

DeBusk, W.F., I. Poyer, and I. Herzfeld. 2002. *Sediment quality in the Pensacola Bay System, Final Report*. Northwest Florida Water Management District. 66 pp.

Ditty, J.G. and R.F. Shaw. 1996. Spatial and temporal distrbution of larval striped mullet (*Mugil cephalus*) and white mullet (*M. curema*, Family Mugilidae) in the northern Gulf of Mexico, with notes on mountain mullet, *Agonostomus monticola*. *Bulletin of Marine Science* 59:271-288.

Duke, T.W., J.I. Lowe and A.J. Wilson, Jr. 1970. A polychlorinated biphenyl (Aroclor 1254®) in the water, sediment and biota of Escambia Bay, Florida. *Bulletin of Environmental Contam. Toxicol.* 5:171-180.

Eggold, B.T. and P.J. Motta. 1992. Ontogenetic dietary shifts and morphological correlates in striped mullet, *Mugil cephalus*. *Environmental Biology of Fishes* 34:139-158.

Gelsleichter, J., C.A. Manire, N.J. Szabo, E. Cortes, J. Carlson, and L. Lombardi-Carlson. 2005. Organochlorine concentrations in bonnethead sharks (*Sphyrna tiburo*) from Four Florida Estuaries. *Arch. Environ. Contam. Toxicol.* 48:474-83.

Giam, C.S., A.R. Hanks, R.L. Richardson, W.M. Sackett, and W.K. Wong. 1972. DDT, DDE, and polychlorinated biphenyls in biota from the Gulf of Mexico and Caribbean Sea- 1971. *Pest. Monit. J.* 6:139-143.

Giam, C.S., R.L. Richardson, D. Taylor, and M.K. Wong. 1974. DDT, DDE and PCBs in the tissues of reef dwelling groupers (Serranidae) in the Gulf of Mexico and the Grand Bahamas. *Bull. Environ. Contam. Toxicol*. 11:189-192

Giam, C.S., R.L. Richardson, W.K. Wong, A.R. Hanks, and W.M. Sackett. 1973. Chlorinated hydrocarbons in plankton from the Gulf of Mexico and northern Caribbean. *Bull. Envion. Contam. Toxicol*. 9:376-382.

Harrington, R.W. and E.S. Harrington. 1961. Food selection among fishes invading a high subtropical salt marsh: from onset of flooding though the progress of mosquito brood. *Ecology* 45:646-666.

Harvey, J., L. Harwell, and J.K. Summers. 2008. Contaminant concentrations in whole-body fish and shellfish from US estuaries. *Environmental Monitoring and Assessment* 137:403-412.

Hasler, A.D. and W.J. Wisby. 1958. The return of displaced largemouth bass and green sunfish to a "home" area. *Ecology* 39:289-293.

Hemming, J.M., M.S. Brim, and R.B. Jarvis 2002. *Dioxin and Furan Compounds in the Sediments of Florida Panhandle Bay Sediments.* Pub. No, PCFO-EC 02-01, US Fish and Wildlife Service. (DRAFT)

Howell, N.L., M.P. Suarez, H.S. Rifai, and L. Koenig. 2007. Concentrations of Polychlorinated biphenyls (PCBs) in water, sediment, and aquatic biota in the Houston Ship Channel, Texas. *Chemosphere* 70:593-606.

Ibáñez, A.L. and O.G. Benítez. 2004. Climate variables and spawning migrations of the striped mullet and white mullet in the north-western area of the Gulf of Mexico. *Journal of Fish Biology* 65:822-831.

Johnson-Restrepo, B., K. Kannan, R. Addink, D.H. Adams. 2005. Polybrominated diphenyl ethers and polychlorinated biphenyls in a marine foodweb of coastal Florida. Environ. Sci. Technol. 39:8243-8250

Kannan, K., H. Nakata, R.Stafford, G.R. Masson, S. Tanabe, and J.P. Giesy. 1998. Bioaccumulation and toxic potential of extremely hydrophobic polychlorinated biphenyl congeners in biota collected at a superfund site contaminated with Aroclor 1268. *Environ. Sci. Technol.* 32:1214-1221.

Karouna-Renier, N.K., R.A. Snyder, J.G. Allison, M.G. Wagner, and K.R. Rao. 2007. Accumulation of organic and inorganic contaminants in shellfish collected in estuarine waters near Pensacola, Florida: Contamination profiles and risks to human consumers. *Environmental Pollution* 145:474-488.

Kennicutt, M.C. II, J.M. Brooks, E.L. Atlas, and C.S. Giam. 1988. Orgnaic compounds of environmental concern in the Gulf of Mexico: a review. *Aquatic Toxicology* 11:191-212.

Krahn, M., D.W. Brown, G.M. Ylitalo, and T.K. Collier. 2005. *Analysis of edible tissue from fish collected in coastal waters of the Gulf of Mexico affected by Hurricane Katrina to determine recent exposure to persistent organic pollutants (POP's).* http://www.st.nmfs.gov/hurricane_katrina/water_sediment_survey.html)

Lewis, M.A., J.C. Moore, L.R. Goodman, J.M. Patrick, R.S. Stanley, T.H. Roush, and R.L. Quarles. 2001. The effects of urbanization on the chemical quality of three tidal bayous in the Gulf of Mexico. *Water Air and Soil Pollution* 127:65-91.

Lewis, W.M. and S. Flickinger. 1967. Home range tendancy of the largemouth bass (*Micropterus salmoides*). *Ecology* 48:1020-1023.

Ludsin, S.A. and D.R. DeVries. 1997. First-year recruitment of largemouth bass: the interdependency of early life stages. *Ecological Applications* 7:1024-1038.

Matthews, J.H. 1928. Fisheries of the south Atlantic and Gulf states. *Economic Geography* 4:323-348.

Mesing, C. L. and A. M. Wicker. 1986. Home ranges, spawning migrations, and homing of radio-tagged Florida largemouth bass in two central Florida lakes. *Transactions of the American Fisheries Society* 115:286-295.

Nimmo, D.R., D.J. Hansen, J.A. Couch, N.R. Cooley, P.R. Parrish, and J.I. Lowe. 1975. Toxicity of Aroclor® 1254 and its physiological activity in several estuarine organisms. *Archives of Environmental Contamination and Toxicology* 3:22-39.

Odum, W.E. 1970. Utilization of the direct grazing and plant detritus food chains by the striped mullet *Mugil cephalus*, pp. 222-240. *In*: *Marine food chains*. J. H. Steele, ed. Univ. of California Press, Berkeley.

Oliver, L.M., W.S. Fisher, J.T. Winstead, B.L. Hemmer, and E.R. Long. 2001. Relationships between tissue, contaminants, and defense related characteristics of oysters (*Crassostrea virginica*) five Florida bays. *Aquat. Toxicol*. 55:203-222.

Padfield, J.H.Jr. 1951. Age and growth differentiation between sexes of the largemouth black bass *Micropterus salmoides* (Lacepede). *Journal of the Tennesee Academy of Science* 26:42-54.

Park, J.-S., T.L. Wade, and S. Sweet. 2001. Atmospheric deposition of organochlorine contaminants to Galveston Bay, Texas. *Atmospheric Environment* 35:3315-3324.

Parrar, M.N., P.B. Hodges, E.V. John, W.R. Richard, and E.P. Wheeler. 1969. *Report of Aroclor Ad-hoc Committee*. Monsanto Chemical Co.

Post, D.M. 2003. Individual variation in the timing of ontogenetic niche shifts in largemouth bass. *Ecology* 84:1298-1310.

Rider, S.J. and D.H. Adams. 2000. Mercury concentration in spotted seatrout (*Cynoscion nebulosus*) from Northwest Florida. *Gulf of Mexico Science* 2:97-103.

Rivas, L.R. 1980. Synopsis of Knowledge of the taxonomy, biology, distribution, and fishery of the Gulf of Mexico mullets (Pisces: Mugilidae), pp. 34-53 *In*: *Proceedings of a workshop for potential fishery resources of the northern Gulf of Mexico*. M. Flandorfer and L. Skupien, eds. MASGP-80-012, Mississippi-Alabama State Grant Consortium, Ocean Springs, Miss.

Rosales, M.T.L., A.V. Botello, H. Bravo, and E.F. Mandelli. 1979. PCBs and organochlorine insecticides in oysters from coastal lagoons of the Gulf of Mexico. *Bull. Envion. Contam. Toxicol.* 21:652-656.

Rubinstein, N.I., W.T. Giliam, and N.R. Gregory. 1984. Dietary accumulation of PCBs from a contaminated sediment source by a demersal fish (*Leiostomus xanthurus*). *Aquatic Toxicology* 5:331-342.

Salata, G.G.; T.L. Wade, J.L. Sericano, J.W. Davis, J.M. Brooks. 1995. Analysis of Gulf of Mexico bottlenose dolphins for organochlorine pesticides and PCBs. *Environmental Pollution* 88(2):167-175.

Snyder, R.A., W.F. Patterson III, S. Gibson, S. Jeffers, and A. Ren. 2007. *Pre-Reefing Environmental Assessment for the ex-ORISKANY.* Final Report to Computer Services Corporation (US NAVY). http://www.uwf.edu/rsnyder/reports/Oriskrpt.pdf

US EPA. 2000. Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis. 3rd ed. EPA 823-B-00-007.

Van den Berg, M., L. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama. A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, and R.E. Peterson, 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. *Toxicological Sciences* 93:223-241.

Wade, T.L., B. Garcia-Romero, and J.M. Brooks. 1988. Tributyltin contaminationof bivalves from U.S. coastal estuaries. *Env. Sci. Technol.* 22:1488-1492.

Watanabe, M., K. Kannan, A. Takahashi, B.G. Loganathan, D.K. Odell, S. Tanabe, and J.P. Giesy. 2000. Polychlorinated biphenyls, organochlorine pesticides, tris(4-chlorophenyl)methane, and tris(4-chlorophenyl)methanol in livers of small cetaceans stranded along Florida coastal waters, USA. *Environmental Toxicology and Chemistry* 19: 1566-1574.

Wells, R.S., V. Tornero, A. Borrell, A. Aguilar, T.K. Rowles, H.L. Rhinehart, S. Hofmann, W.M. Jarman, A.A. Hohn, J.C. Sweeney 2005. Integrating life-history and reproductive success data to examine potential relationships with organochlorine compounds for bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. *The Science of the Total Environment* 349(1-3):106-19.

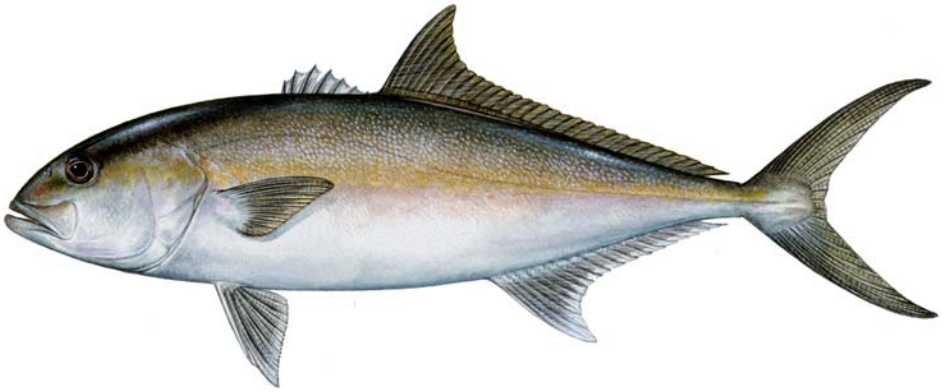
Wilson, A.,and J. Forester. 1978. Persistence of Aroclor 1254 in a contaminated estuary. *Environmental Research Laboratory* 19: 637-640.

## Individual species pages



All analyses used a zero value for non-detected molecules instead of one half the detection limit. US EPA screening values for Hg (0.4 mg/kg), total PCBs (20 μg/kg), and TEQ (0.256 ng/kg) based on recreational fisher consumption rates 17g day$^{-1}$ were used as target thresholds. State of Florida thresholds for Hg (0.6 mg/kg) and total PCBs (50 mg/kg) were also used. The State of Florida does not have a standard threshold for TEQ.

Fish images used by permission of:
Florida Department of Environmental Protection
Dianne Peebles, artist.
Pictures are not to scale.
Shrimp image: R. Snyder

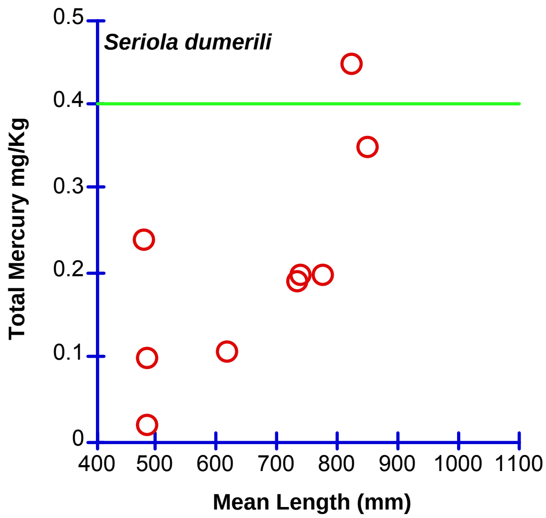


## Greater Amberjack
*Seriola dumerilli*

**Sample locations:** offshore

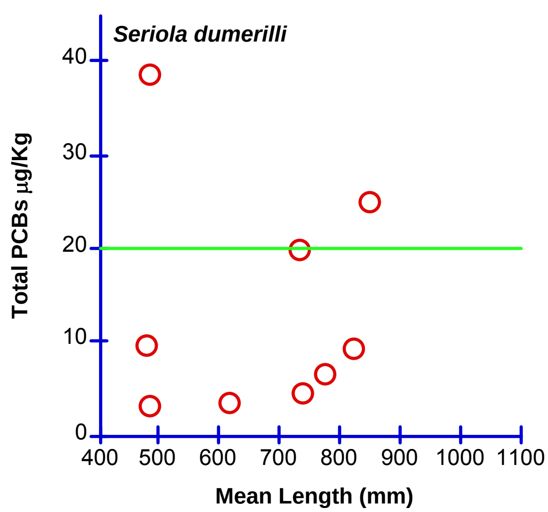
A total of 9 fish (7 Greater, 2 Lesser) were collected over offshore reefs. Mercury concentrations show a tendency to accumulate with size, but only one specimen out of nine (the larger of the two lesser amberjack) exceeded the US EPA screening value. Three fish out of nine were at or exceeded the US EPA screening value for PCBs

### Mercury Content

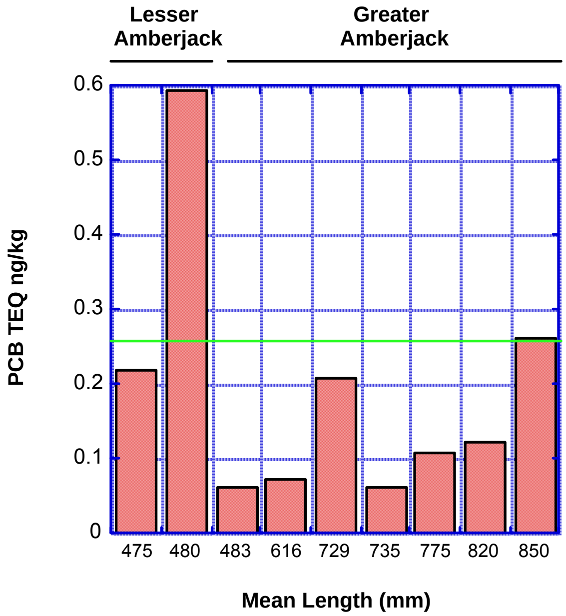



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

### PCB Content

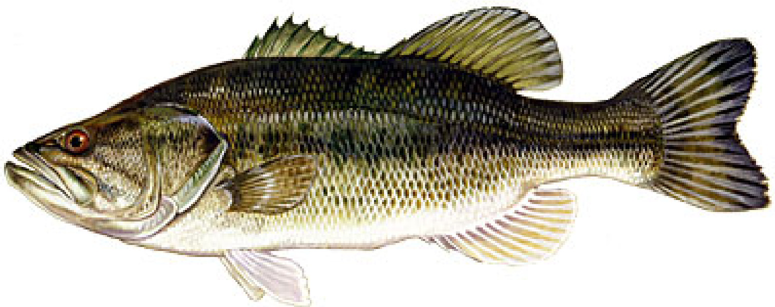



Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.



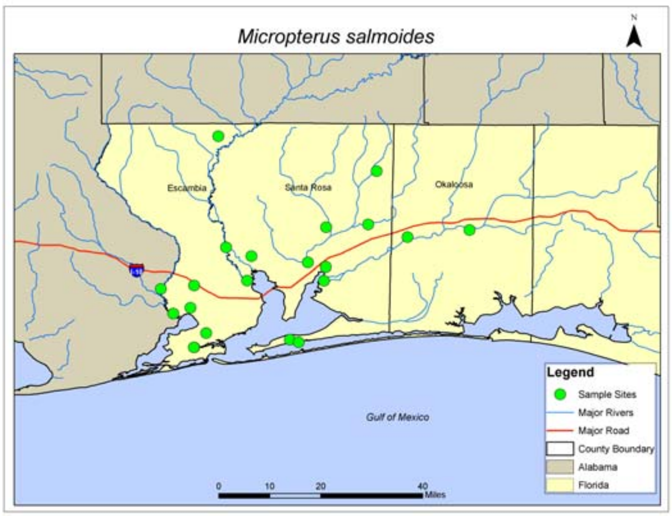

Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

| Location | Species | n | Mean Length (mm) | Mean Weight (g) | % Lipid | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | *Seriola dumerilli* | 1 | 475 | 2030.0 | 0.40 | 0.2202 | 9.7520 | 0.24 | 29.847 | -87.304 |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 616 | 3420.0 | 0.07 | 0.0734 | 3.550 | 0.11 | | |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 735 | 5380.0 | 0.06 | 0.0622 | 4.500 | 0.2 | | |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 729 | 6320.0 | 0.40 | 0.2093 | **19.900** | 0.19 | 29.300 | -87.017 |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 775 | 6450.0 | 0.10 | 0.1071 | 6.860 | 0.2 | 29.383 | -87.917 |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 820 | 9330.0 | 0.50 | 0.1234 | 9.59 | **0.45** | 29.847 | -87.304 |
| Offshore outer shelf | *Seriola dumerilli* | 1 | 850 | 8150.0 | 0.13 | **0.2625** | **25.200** | 0.35 | 29.383 | -87.917 |
| Offshore outer shelf | *Seriola rivoliana* | 1 | 480 | 2470.0 | 0.41 | **0.5934** | **38.800** | 0.1 | 30.043 | -87.007 |
| Offshore outer shelf | *Seriola rivoliana* | 1 | 483 | 1970.0 | 0.00 | 0.0621 | 3.450 | 0.02 | 29.300 | -88.017 |



# Largemouth Bass
*Micropterous salmoides*

## Sample Locations




**Mercury content**

Generally high throughout the area, limited consumption advisory.
No-consumption advisory for Woodbine Springs Lake

**Areas with High PCB content**

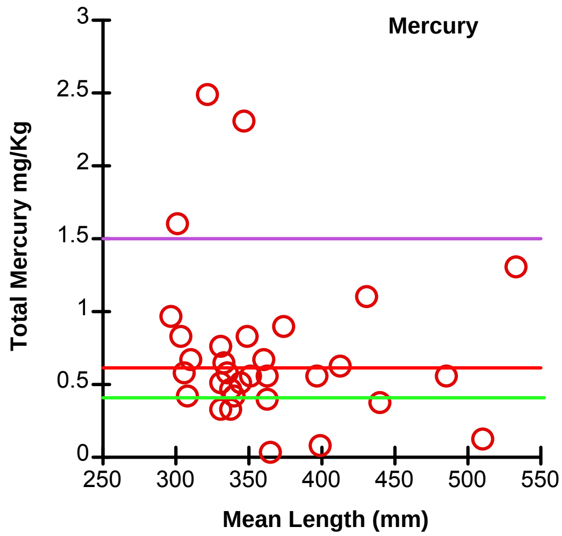
Lower Escambia River

**Areas with low PCB content**

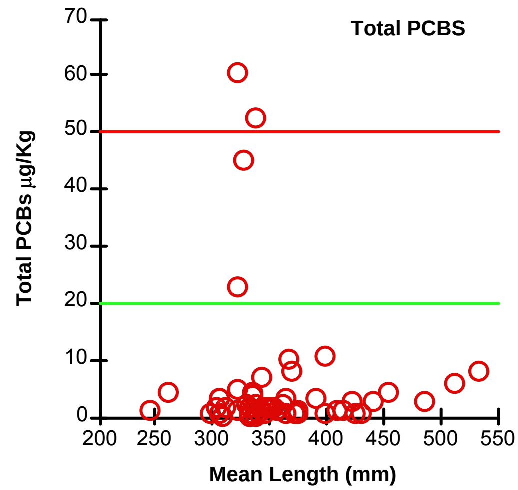
All other freshwaters sampled

A total of 163 fish from 20 locations were included in 55 samples. Single fish comprised nine samples, and the remaining 46 were composite samples of 3 or more fish. Mercury content was generally high throughout the area, and a State of Florida limited consumption advisory exists for most of the waterways sampled. A State of Florida no consumption advisory based on mercury content exists for Woodbine Lake. Samples from the lake had the highest mercury concentrations of any bass sampled.

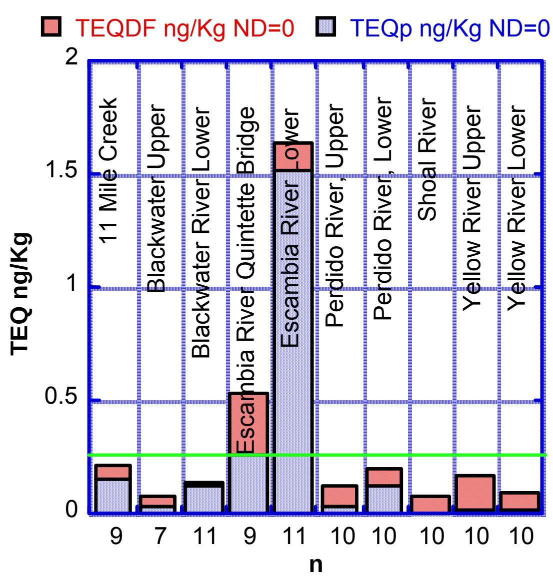
PCB and Dioxins/Furans content was low in all samples, except for the PCB loads in fish collected from the lower Escambia River, where PCB content in bass triggered a limited consumption advisory from the State of Florida.



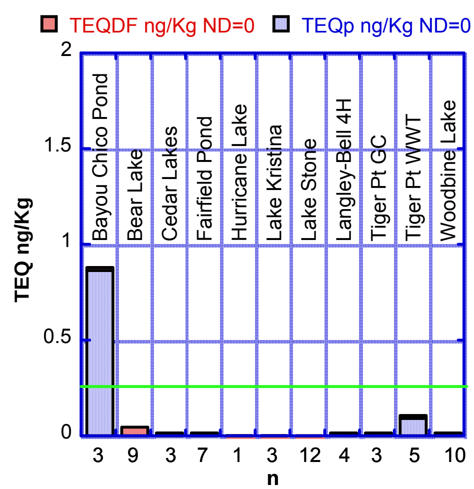

Green line: US EPA recreational consumption action limit. Red line: State of Florida threshold for limited consumption. Purple line: State of Florida threshold for no consumption advisory.




Green line: US EPA recreational consumption action limit at 20 µg/kg. Red line: State of Florida action limit at 50 µg/kg.



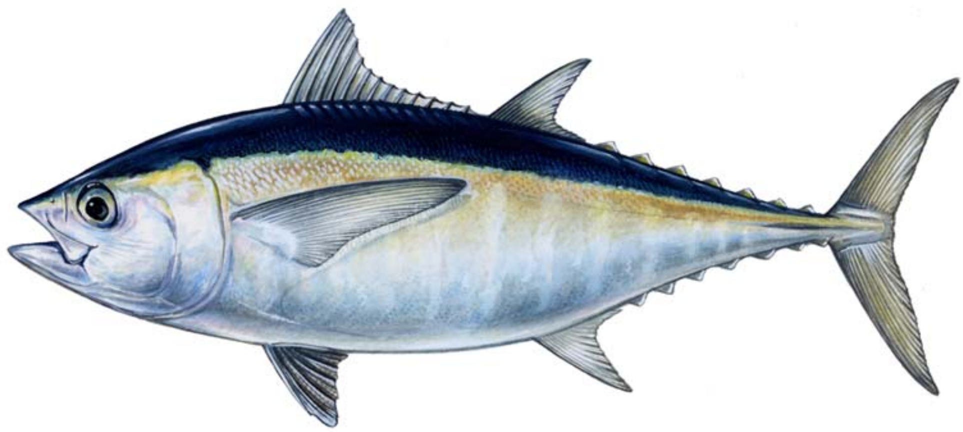

Toxicity of Dioxins Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in Largemouth Bass from NW Florida Rivers. High values were obtained for fish collected in the Escambia river. The green line is the US EPA recreational consumption action limit at 0.26 ng/kg. State of Florida does not have an official action limit established for TEQ values.




Toxicity of Dioxin Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in Largemouth Bass from NW Florida Ponds. The only high value recorded was for a composite of specimens from a borrow pit that received dredge spoil from Bayou Chico. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values.

| Location | n | Mean Length (mm) | Mean Wt (g) | Sex | Mean Age | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 Mile Creek | 3 | 260 | 224.0 | | 2.1 | 0.10 | 0.1045 | **0.3546** | **0.4591** | 4.710 | 0.3600 | 30.456 | -87.377 |
| 11 Mile Creek | 3 | 321 | 1836.3 | F | 3.6 | 0.10 | 0.0727 | 0.1175 | 0.1902 | 4.890 | **0.4200** | 30.456 | -87.377 |
| 11 Mile Creek | 3 | 335 | 518.0 | M | 2.6 | 0.30 | 0.0161 | 0.0011 | 0.0172 | 2.620 | 0.3200 | 30.456 | -87.377 |
| 11 Mile Creek | 1 | 439 | 1070.0 | F | | | | | | 3.115 | 0.3667 | 30.456 | -87.377 |
| Bayou Chico Pond | *3* | 366 | 573.8 | | 3.3 | 0.20 | 0.0170 | 0.8609 | 0.8779 | 10.324 | 0.0400 | 30.402 | -87.273 |
| Bear Lake 1 | *3* | 362 | 703.1 | | 3.7 | 0.40 | 0.0678 | 0.0000 | 0.0678 | 0.774 | **0.4100** | 30.863 | -86.835 |
| Bear Lake 2 | *3* | 330 | 481.7 | | 2.0 | 0.50 | 0.0671 | 0.0000 | 0.0671 | 0.550 | 0.3400 | 30.863 | -86.835 |
| Bear Lake 3 | *3* | 338 | 555.1 | | 2.7 | 0.60 | 0.0127 | 0.0000 | 0.0127 | 0.665 | 0.3400 | 30.863 | -86.835 |
| Blackwater River Lower | 4 | 329 | 512.3 | | | 0.20 | 0.0062 | 0.0569 | 0.0631 | 2.670 | **0.5800** | 30.603 | -87.030 |
| Blackwater River Lower | 3 | 352 | 655.3 | | | 0.20 | 0.0000 | 0.0678 | 0.0678 | 2.120 | **0.5500** | 30.603 | -87.030 |
| Blackwater River Lower | 4 | 367 | 644.5 | M | | 0.10 | 0.0474 | 0.2510 | **0.2984** | 8.270 | **0.5800** | 30.603 | -87.030 |
| Blackwater Upper | 4 | 304 | 349.0 | | | 0.50 | 0.0598 | 0.0575 | 0.1173 | 0.841 | **0.7600** | 30.711 | -86.858 |
| Blackwater Upper | 3 | 371 | 655.7 | | | 0.20 | 0.0422 | 0.0001 | 0.0423 | 0.872 | **1.0200** | 30.711 | -86.858 |
| Cedar Lakes | *3* | 348 | 553.3 | | 3.7 | 0.20 | 0.0171 | 0.0002 | 0.0173 | 2.058 | 0.8400 | 30.591 | -86.979 |
| Escambia River Quintette Bridge | 4 | 244 | 431.8 | | | 0.80 | 0.1010 | 0.0005 | 0.1015 | 1.580 | **0.6000** | 30.646 | -87.262 |
| Escambia River Quintette Bridge | 4 | 341 | 684.0 | | | 1.00 | **0.3550** | **0.8059** | **1.1609** | 1.640 | **0.5300** | 30.646 | -87.262 |
| Escambia River Quintette Bridge | 1 | 396 | 990.0 | F | | | | | | 0.807 | **0.5643** | 30.646 | -87.262 |
| Escambia River Quintette Bridge | 1 | 407 | 1067.0 | F | | | **0.3495** | 0.0003 | **0.3498** | 1.410 | | 30.646 | -87.262 |
| Escambia River Lower | 4 | 320 | 400.8 | M | | 0.10 | 0.1830 | **0.4273** | **0.6103** | **23.400** | **0.4700** | 30.554 | -87.202 |
| Escambia River Lower | 3 | 322 | 487.7 | M | 4.3 | 0.30 | 0.0260 | **2.5088** | **2.5348** | **61.000** | **0.4500** | 30.554 | -87.202 |
| Escambia River Lower | 4 | 326 | 441.3 | | 2.0 | 0.10 | 0.1236 | **1.6401** | **1.7637** | **45.400** | **0.4600** | 30.554 | -87.202 |
| Escambia River Lower | 3 | 337 | 516.7 | M | | | | | | **52.697** | **0.4601** | 30.554 | -87.202 |
| Fairfield Pond | *3* | 332 | 450.0 | | 4.0 | 0.30 | 0.0090 | 0.0026 | 0.0116 | 4.320 | **0.6600** | 30.404 | -87.319 |
| Fairfield Pond | *3* | 362 | 601.5 | | 3.0 | 0.10 | 0.0130 | | | 3.776 | **0.5700** | 30.404 | -87.319 |
| Fairfield Pond | *1* | 532 | 1970.0 | | 6.0 | 0.20 | 0.0479 | | | 8.281 | **1.3000** | 30.404 | -87.319 |
| Hurricane Lake | *1* | 340 | 376.9 | | 4.0 | 0.20 | 0.0049 | 0.0001 | 0.0050 | 0.879 | **0.4200** | 30.201 | -87.117 |
| Lake Kristina | *3* | 307 | 356.7 | | 2.3 | 0.20 | 0.0100 | 0.0001 | 0.0101 | 0.161 | **0.4300** | 30.703 | -86.978 |
| Lake Stone 1 | *4* | 345 | 554.9 | | 3.3 | 0.00 | 0.0064 | 0.0000 | 0.0064 | 0.728 | **0.5100** | 30.962 | -87.284 |
| Lake Stone 2 | *4* | 331 | 488.3 | | 3.3 | 0.00 | 0.0063 | 0.0000 | 0.0063 | 0.666 | **0.5100** | 30.962 | -87.284 |
| Lake Stone 3 | *4* | 336 | 468.5 | | 4.0 | 0.00 | 0.0085 | 0.0000 | 0.0085 | 0.537 | **0.5800** | 30.962 | -87.284 |
| Langley-Bell 4H | *3* | 296 | 272.3 | | 3.7 | 1.90 | 0.0240 | 0.0002 | 0.0242 | 1.060 | **0.9600** | 30.539 | -87.352 |
| Langley-Bell 4H | *1* | 430 | 780.0 | | 5.0 | 0.10 | 0.0076 | 0.0002 | 0.0078 | 1.070 | **1.1000** | 30.539 | -87.352 |
| Perdido River Lower | 4 | 330 | 498.8 | | | 0.20 | 0.0995 | 0.0969 | 0.1964 | 2.170 | **0.6500** | 30.530 | -87.447 |
| Perdido River Lower | 4 | 334 | 476.8 | | | 0.10 | 0.0709 | 0.1232 | 0.1941 | 4.240 | **0.4500** | 30.460 | -87.412 |
| Perdido River Lower | 3 | 374 | 662.7 | M | | 0.20 | 0.0843 | 0.0004 | 0.0847 | 1.280 | **0.8100** | 30.530 | -87.447 |
| Perdido River Lower | 3 | 388 | 791.3 | | | 0.20 | 0.0970 | 0.1251 | 0.2221 | 3.340 | **0.6000** | 30.460 | -87.412 |
| Perdido River Lower | 3 | 421 | 1079.3 | | | 0.10 | 0.0866 | 0.0053 | 0.0919 | 2.870 | **0.8600** | 30.530 | -87.447 |

| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | Mean Age | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Perdido River Lower | 3 | 454 | 1311.7 | F | | 0.20 | 0.2270 | 0.1687 | **0.3957** | 4.320 | **0.6300** | 30.460 | -87.412 |
| Perdido River Lower | 1 | 485 | 1665.0 | F | | | | | | 2.912 | **0.5605** | 30.460 | -87.412 |
| Shoal River | 4 | 305 | 373.3 | M | | 0.50 | 0.1030 | 0.0078 | 0.1108 | 3.360 | **0.4700** | 30.696 | -86.571 |
| Shoal River | 3 | 355 | 714.7 | M | | 0.40 | 0.0000 | 0.0002 | 0.0002 | 1.510 | **0.7700** | 30.696 | -86.571 |
| Shoal River | 3 | 413 | 1095.7 | F | | 0.70 | 0.1140 | 0.0005 | 0.1145 | 1.250 | **0.6400** | 30.696 | -86.571 |
| Tiger Pt Golf Course | *3* | 332 | 408.2 | | 3.0 | 0.20 | 0.0200 | 0.0025 | 0.0225 | 4.194 | | 30.385 | -87.081 |
| Tiger Pt WWTP effluent pond | *3* | 305 | 361.3 | | 1.0 | 0.20 | | 0.1522 | | 3.697 | **0.5800** | 30.378 | -87.056 |
| Tiger Pt WWTP effluent pond | *1* | 398 | 750.0 | | 3.0 | 0.20 | 0.0190 | 0.1524 | 0.1714 | 11.200 | 0.0900 | 30.378 | -87.056 |
| Tiger Pt WWTP effluent pond | *1* | 510 | 1068.0 | | 8.0 | 0.10 | 0.0097 | 0.0029 | 0.0126 | 6.080 | 0.1300 | 30.378 | -87.056 |
| Woodbine Springs 1 | *4* | 301 | 323.9 | | 1.0 | 0.20 | 0.0070 | 0.0250 | 0.0320 | 1.764 | **1.6000** | 30.621 | -87.190 |
| Woodbine Springs 2 | *3* | 321 | 435.7 | | 2.0 | 0.20 | 0.0000 | 0.0004 | 0.0004 | 1.241 | **2.5000** | 30.621 | -87.190 |
| Woodbine Springs 3 | *3* | 345 | 463.3 | | 2.3 | 0.30 | 0.0083 | 0.0012 | 0.0095 | 2.006 | **2.3000** | 30.621 | -87.190 |
| Yellow River Lower | 4 | 309 | 378.0 | | | 0.20 | 0.0500 | 0.0003 | 0.0503 | 1.670 | **0.6803** | 30.553 | -86.984 |
| Yellow River Lower | 3 | 341 | 560.0 | | | 0.20 | 0.1730 | 0.0144 | 0.1874 | 7.330 | **0.8100** | 30.553 | -86.984 |
| Yellow River Lower | 3 | 373 | 822.3 | F | | 0.10 | 0.0140 | 0.0467 | 0.0607 | 1.090 | **0.7000** | 30.553 | -86.984 |
| Yellow River Upper | 3 | 361 | 779.3 | | | 1.20 | 0.1215 | 0.0047 | 0.1262 | 2.540 | **0.7400** | 30.675 | -86.747 |
| Yellow River Upper | 3 | 424 | 1225.7 | F | | 2.80 | **0.2850** | 0.0004 | **0.2854** | **0.971** | **0.7400** | 30.675 | -86.747 |
| Yellow River, Upper | 4 | 346 | 643.3 | F | 54.0 | 0.56 | 0.0515 | 0.0543 | 0.1058 | 1.980 | **0.6500** | 30.675 | -86.747 |

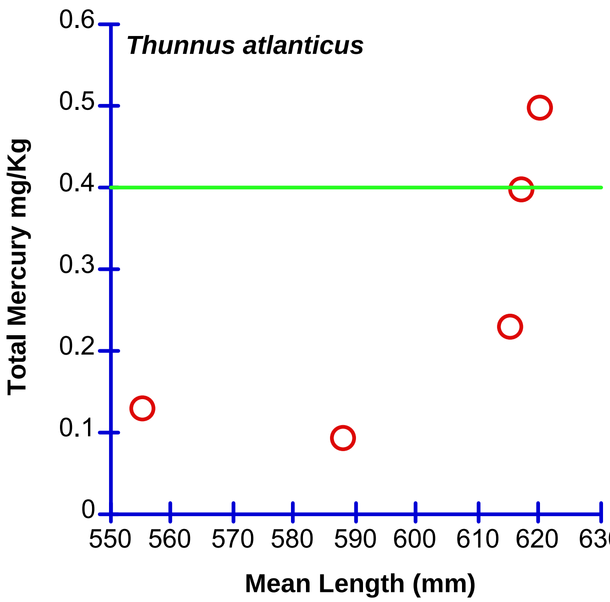


# Blackfin Tuna
*Thunnus atlanticus*

**Sample locations:** offshore

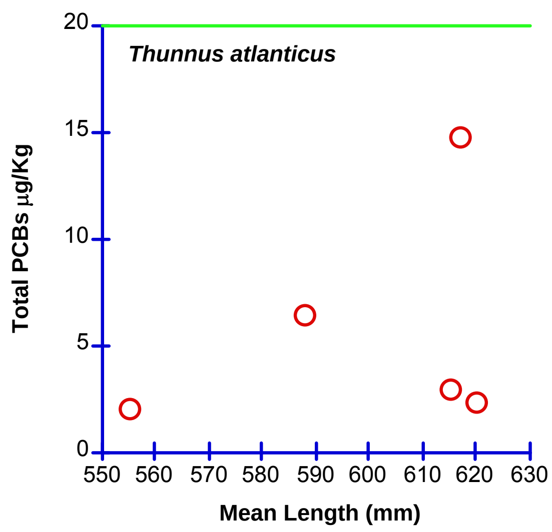
Five fish were sampled offshore. This limited sampling suggested bioaccumulation of both mercury and PCBs with size, with two of the larger fish exceeding the US EPA screening value for mercury content, although none of the fish (up to 62 cm) exceeded the PCB or TEQ thresholds.

## Mercury Content

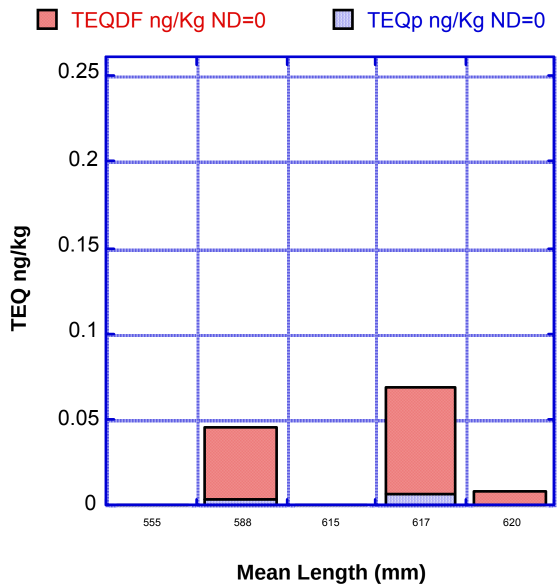



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content

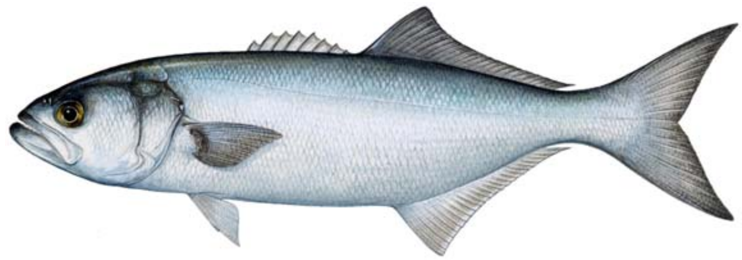



Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.




Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ is 0.256 ng/kg.

| Location | n | Mean Length (mm) | % Lipids | $TEQ_{DF}$ ng/Kg ND=0 | $TEQ_{P}$ ng/Kg ND=0 | $TEQ_{DFP}$ ng/Kg ND=0 | ΣPCBs µg/Kg | Hg mg/Kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Offshore Ram Powell Rig | 1 | 555 | 0.30 | | 0.0010 | | 2.140 | 0.130 | 29.0608 | -88.0917 |
| Offshore Ram Powell Rig | 1 | 588 | 0.20 | 0.0425 | 0.0035 | 0.0460 | 6.510 | 0.096 | 29.0608 | -88.0917 |
| Offshore Ram Powell Rig | 1 | 615 | 0.10 | | 0.0013 | | 2.930 | 0.230 | 29.0608 | -88.0917 |
| Offshore Ram Powell Rig | 1 | 617 | 0.30 | 0.0621 | 0.0071 | 0.0692 | 14.800 | **0.400** | 29.0608 | -88.0917 |
| Offshore Ram Powell Rig | 1 | 620 | 0.40 | 0.0076 | 0.0011 | 0.0087 | 2.430 | **0.500** | 29.0608 | -88.0917 |



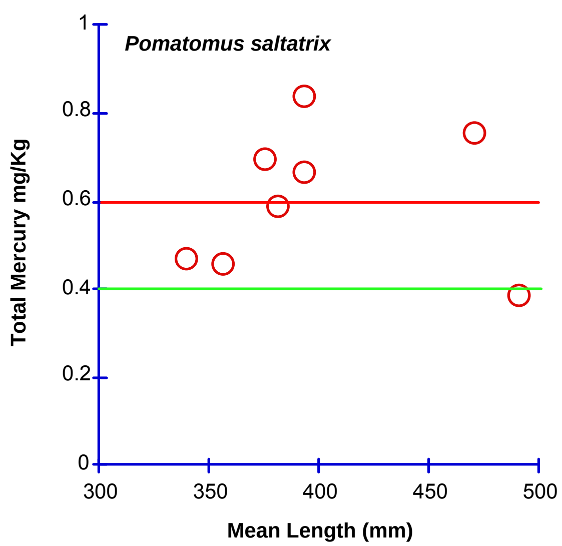
# Bluefish
*Pomatomus saltatrix*

**Sample Locations:** Pensacola Bay, Pensacola Pass, Santa Rosa Island Surf

Samples from 9 fish ranging in size from 34 to 49 cm were collected from Pensacola Bay, Pensacola Pass, and along Santa Rosa Island in the Gulf of Mexico. All fish were at or exceeded the US EPA screening value for mercury, and five out of nine exceeded the State of Florida threshold for limited consumption. Two of the larger fish exceeded the US EPA threshold for total PCB content, and one fish exceeded the State of Florida threshold for PCBs. Six out of nine fish exceeded the US EPA threshold for toxicity (TEQ) of Dioxins/Furans and PCBs.

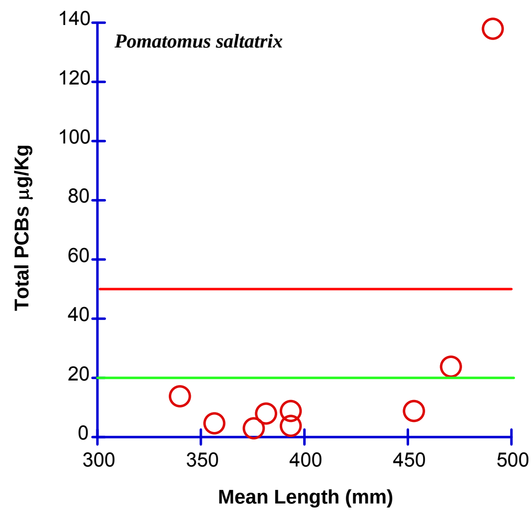
## Mercury Content

Mercury content was high in sampled fish.

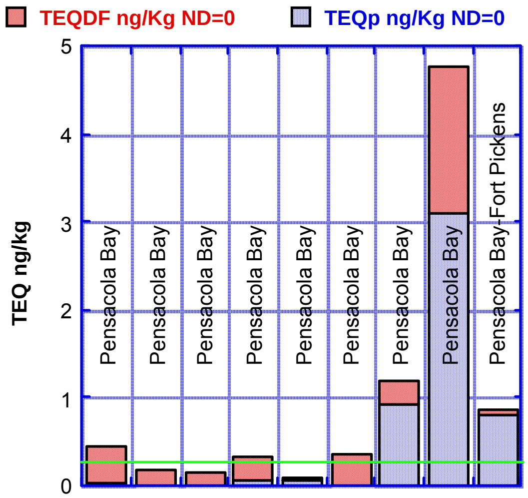



Red line: State of Florida action limit at 0.60 mg/kg. Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content




Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg




Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

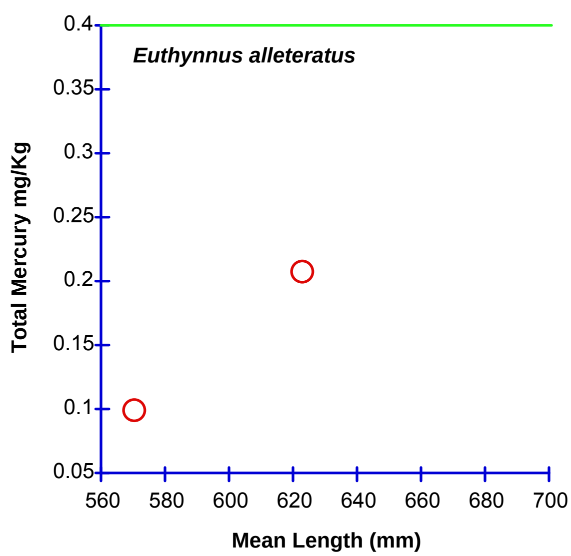
| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg |
|---|---|---|---|---|---|---|---|---|---|
| Pensacola Bay | 1 | 339 | 360.0 | 1.20 | **0.4404** | 0.0204 | **0.4608** | 13.80 | **0.47** |
| Pensacola Bay | 1 | 355 | 420.0 | 1.00 | 0.1649 | 0.0067 | 0.1716 | 4.93 | **0.46** |
| Pensacola Bay | 1 | 375 | 470.0 | 0.40 | 0.1431 | 0.0048 | 0.1479 | 3.10 | **0.7** |
| Pensacola Bay | 1 | 381 | 480.0 | 0.60 | 0.2500 | 0.0701 | **0.3201** | 8.29 | **0.59** |
| Pensacola Bay | 1 | 392 | 560.0 | | 0.0524 | 0.0547 | 0.1071 | 4.280 | **0.67** |
| Pensacola Bay | 1 | 392 | 540.0 | 0.70 | **0.3351** | 0.0124 | **0.3475** | 8.96 | **0.84** |
| Pensacola Bay | 1 | 470 | 980.0 | 0.90 | **0.2740** | 0.9300 | **1.2040** | **24.20** | **0.76** |
| Pensacola Bay | 1 | 490 | 1080.0 | 1.40 | **1.6748** | **3.0968** | **4.7716** | **138.00** | **0.39** |
| Pensacola Bay Fort Pickens | 1 | 452 | 940.0 | 0.40 | 0.0646 | **0.8071** | **0.8717** | 8.940 | |

# **Bonita**
*Euthynnus alleteratus*

**Sample locations**: offshore

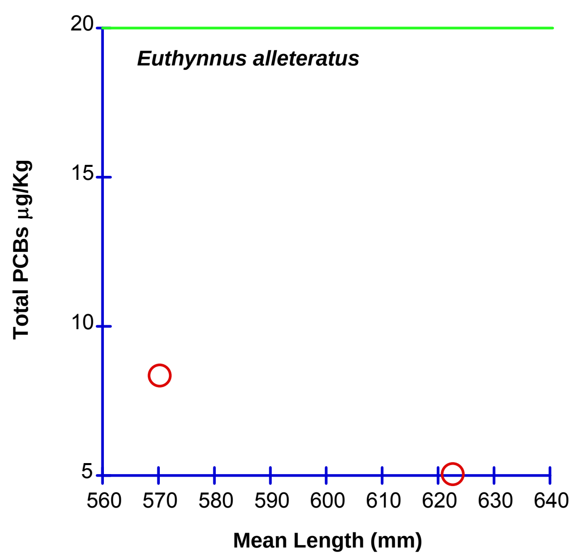
Two specimens were collected offshore, neither exceeded screening values for mercury, PCBs or TEQ.

## Mercury Content




Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content

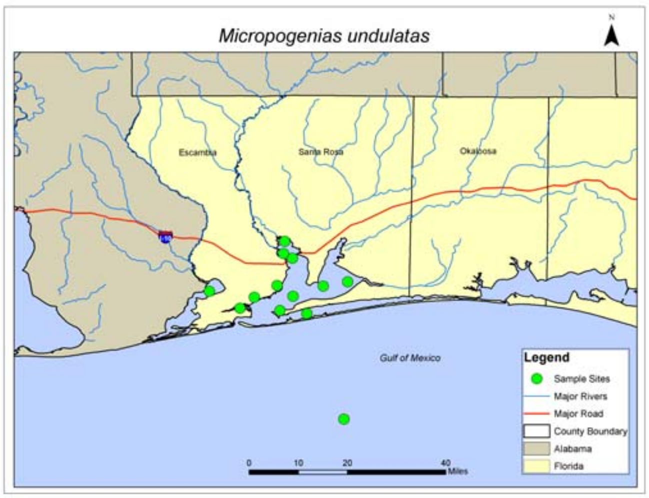



Green line: US EPA recreational consumption action limit at 20 µg/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | % Lipids | $TEQ_P$ ng/Kg ND=0 | ΣPCBs µg/Kg | Hg mg/Kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Pensacola Bay Pass | 1 | 570 | 2050 | F | 1.50 | 0.1324 | 8.351 | 0.1 | 30.3261 | -87.3077 |
| Pensacola Bay Pass | 1 | 622 | 2440 | M | 0.70 | 0.1151 | 5.108 | 0.21 | 30.3261 | -87.3077 |

# Atlantic Croaker
*Micropogenias undulatus*

## Sample locations



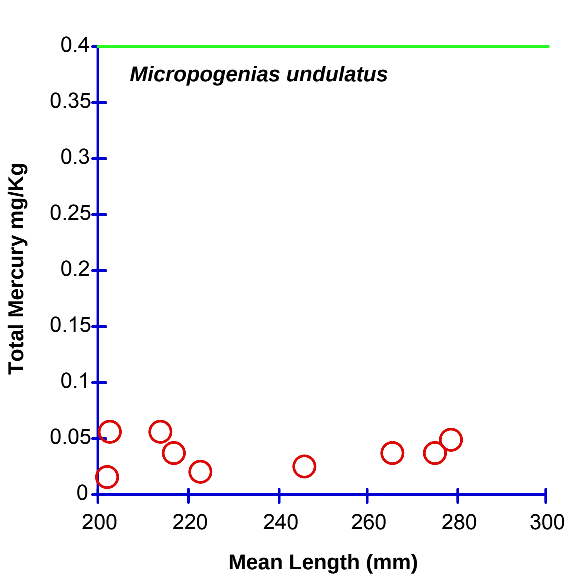

## Mercury Content
Low Mercury content throughout the area.

## Areas with High PCB content

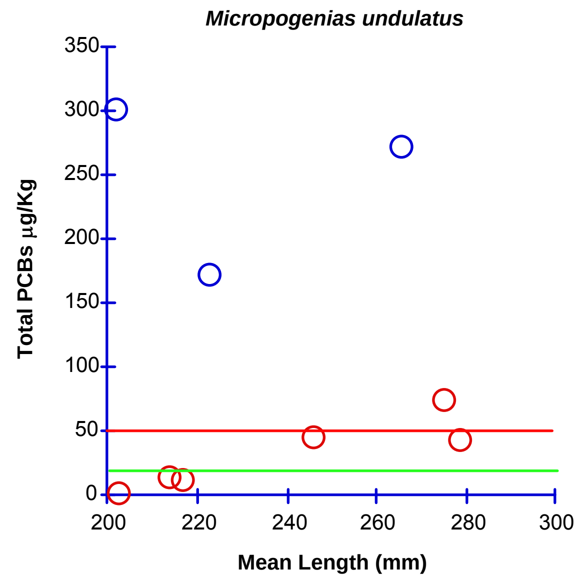
Upper Escambia Bay
Bayous Texar, Chico, Grande

## Areas with low PCB content
East Bay
Bayous Hoffman,Woodlawn
Bayous Texar, Grande
Offshore

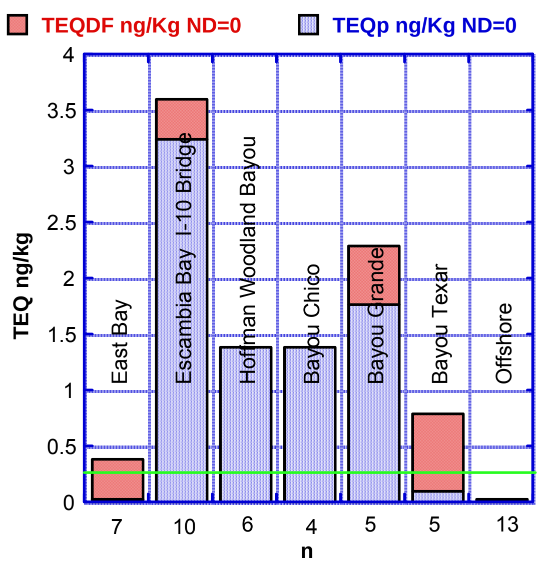
Nine samples containing 50 fish (2 to 13 per composite) had very low concentrations of mercury. PCB content, however, exceed the US EPA threshold in six of nine samples, with three of those collected in the urban bayous (Texar, Chico, Grande) and three during the Escambia Bay I-10 Bridge demolition blast. The Escambia Bay samples were three to six times higher than the samples from the bayous. Samples from East Bay, Hoffman/Woodland Bayou, and offshore had lower concentrations of total PCBs. All samples except from offshore exceeded the US EPA screening value for TEQ (Dioxins/Furans and PCBs).




Green line: US EPA recreational consumption action limit at 0.40 mg/kg




Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg. Blue symbols from I-10 Bridge, Escambia Bay




Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

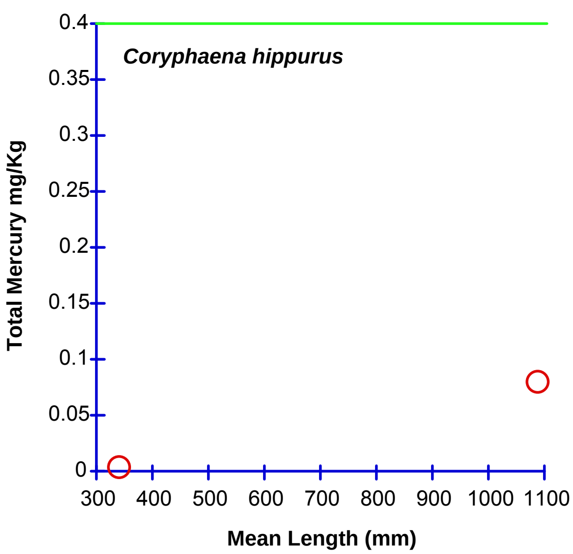
| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bayou Chico | 4 | 246 | 183.5 | 1.80 | | **1.3774** | | **45.800** | 0.026 | 30.404 | -87.255 |
| Bayou Grande | 5 | 275 | 214.6 | 2.90 | 0.5255 | **1.7625** | **2.2880** | **75.940** | 0.040 | 30.372 | -87.297 |
| Bayou Texar | 5 | 278 | 261.9 | 2.80 | 0.6950 | 0.1010 | **0.7960** | **44.999** | 0.052 | 30.439 | -87.188 |
| East Bay | 7 | 214 | 123.7 | 1.20 | 0.3535 | 0.0304 | **0.3839** | 16.098 | 0.059 | 30.450 | -86.980 |
| Escambia Bay I-10 Bridge | 6 | 202 | 99.8 | 2.40 | 0.3365 | **2.6980** | **3.0345** | **303.000** | 0.017 | 30.519 | -87.143 |
| Escambia Bay I-10 Bridge | 2 | 223 | 130.0 | 1.50 | 0.1829 | **2.2893** | **2.4722** | **174.000** | 0.023 | 30.519 | -87.143 |
| Escambia Bay I-10 Bridge | 2 | 265 | 245.0 | 3.40 | 0.5007 | **4.7609** | **5.2616** | **274.000** | 0.039 | 30.519 | -87.143 |
| Hoffman Woodland Bayou | 6 | 217 | 121.8 | 2.30 | | **1.3806** | | 14.341 | 0.038 | 30.365 | -87.179 |
| Offshore outer shelf | 13 | 202 | 98.2 | 1.00 | 0.0000 | 0.0145 | 0.0145 | 2.205 | 0.059 | 30.044 | -86.991 |

## Dolphin (Mahi)
*Coryphaena hippurus*

**Sample locations:** offshore

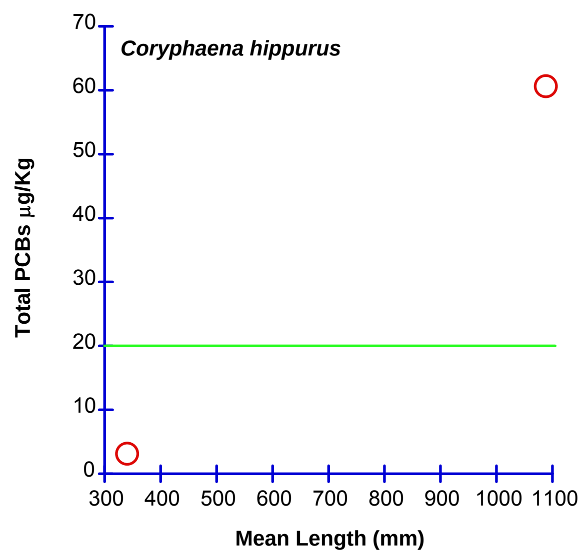
Two fish were sampled from offshore collections, 340 and 1080 cm. Both fish had low mercury content. However the larger fish had 3 times the US EPA total PCB threshold, and also had an elevated TEQ value three times the US EPA screening value for recreational fisher consumption.

### Mercury Content

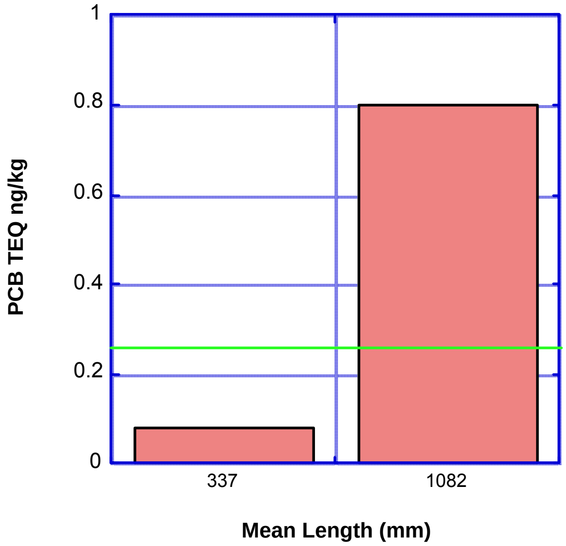



Green line: US EPA recreational consumption action limit at 0.40 mg/kg.

### PCB Content

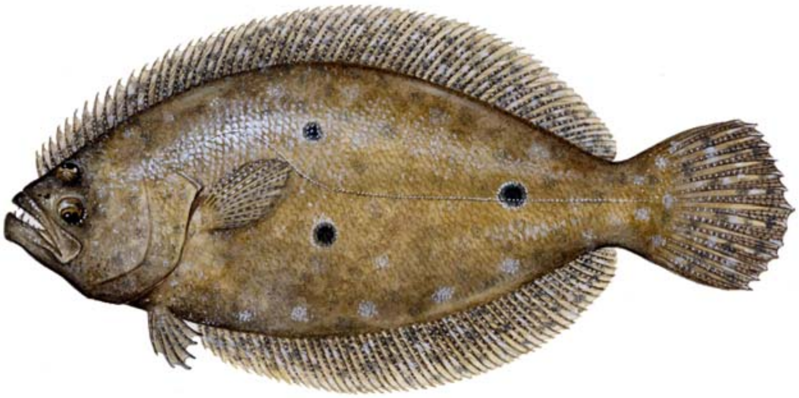



Green line: US EPA recreational consumption action limit at 20 µg/kg.



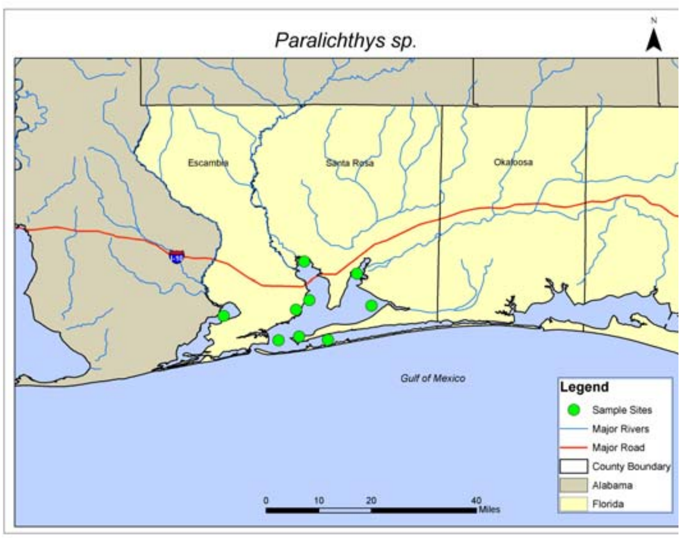

Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumptio action limit for TEQ at 0.256 ng/kg is indicated by the green line

| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | 1 | 337 | 510.0 | F | 0.01 | 0.0787 | 3.190 | 0.0046 | 30.204 | -87.067 |
| Offshore outer shelf | 1 | 1082 | nt | NT | 1.80 | **0.7999** | **60.900** | 0.081 | 29.316 | -88.237 |



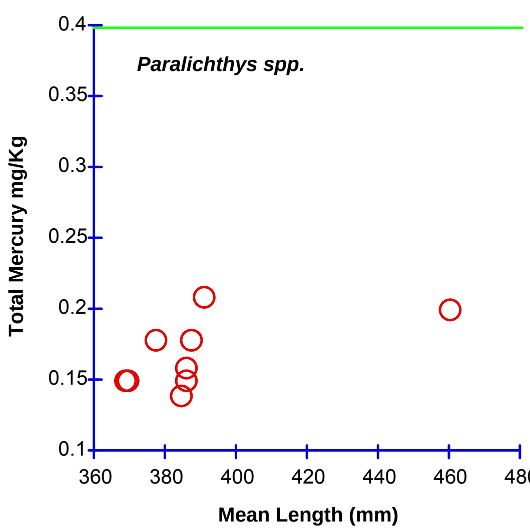
# Flounder
*Paralichthys spp*

## Sample Locations



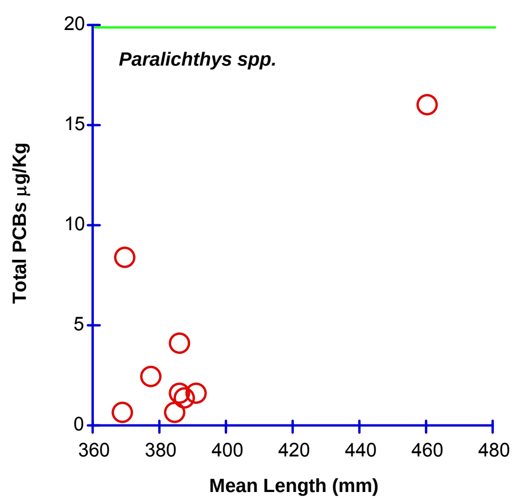

Fish were collected at various locations within the bay system. While there appeared a tendency for elevated mercury and PCBs with size, no fish exceeded US EPA thresholds for these compounds. One sample from the lower Escambia river did have an elevated TEQ value

## Mercury Content

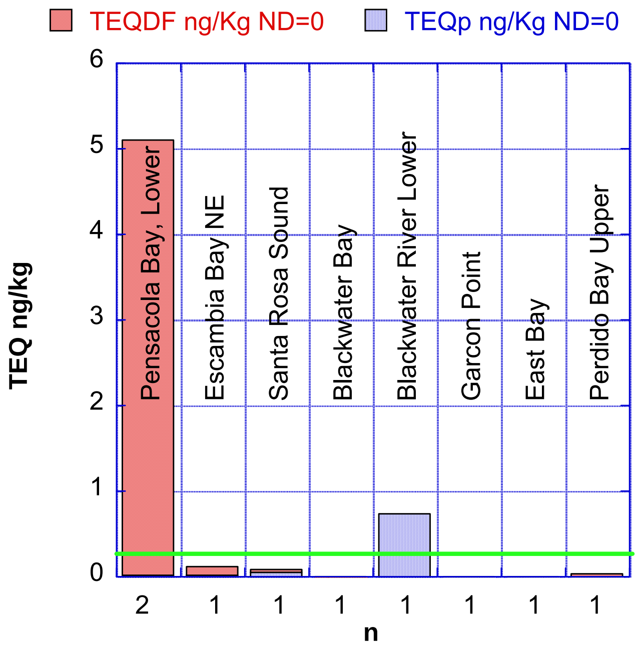



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content

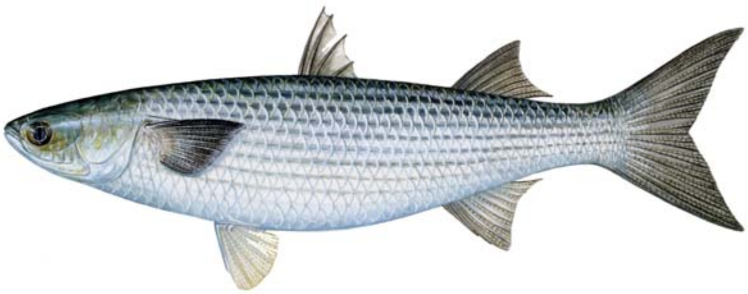



Red line: State of Florida action limit 50 µg/kg. Green line: US EPA recreational consumption limit 20 µg/kg.



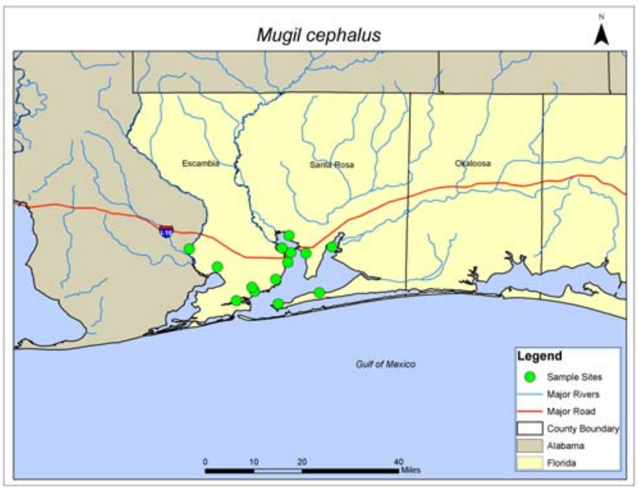

Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pensacola Bay, Lower | 3 | 368 | 550.0 | 0.10 | **10.039** | 0.0014 | **10.041** | 0.711 | 0.150 | 30.355 | -87.236 |
| Blackwater Bay | 3 | 384 | 596.7 | 0.10 | 0.0004 | 0.0009 | 0.0013 | 0.823 | 0.140 | 30.536 | -87.020 |
| Blackwater River Lower | 4 | 385 | 607.5 | 0.30 | | **0.7334** | | 4.224 | 0.150 | 30.536 | -87.020 |
| East Bay | 3 | 387 | 616.7 | 0.20 | 0.0000 | 0.0021 | 0.0021 | 1.420 | 0.180 | 30.450 | -86.980 |
| Garcon Point | 3 | 386 | 613.3 | 0.30 | 0.0000 | 0.0030 | 0.0030 | 1.740 | 0.160 | 30.465 | -87.151 |
| Escambia Bay NE | 3 | 369 | 684.6 | 0.30 | 0.1053 | 0.0201 | 0.1254 | 8.511 | 0.150 | 30.569 | -87.165 |
| Pensacola Bay, Lower | 3 | 460 | 1160.0 | 0.40 | 0.1130 | 0.0316 | 0.1446 | 16.065 | 0.200 | 30.355 | -87.236 |
| Perdido Bay Upper | 3 | 390 | 650.0 | 0.20 | 0.0350 | 0.0033 | 0.0383 | 1.718 | 0.210 | 30.422 | -87.387 |
| Santa Rosa Sound | 3 | 377 | 682.5 | 0.40 | 0.0370 | 0.0493 | 0.0863 | 2.598 | 0.180 | 30.356 | -87.100 |



# Striped Mullet
# *Mugil cephalus*

## Sample Locations




## Areas with High PCB content

Lower Escambia River
Escambia River Delta
Upper and West Escambia Bay
Bayou Chico

Samples of skin-on fillets had twice the PCB load of skinless fillets.

## Areas with low PCB content

Indian/Trout Bayous, East Escambia Bay
East Bay, Blackwater Bay
Pensacola Bay
Santa Rosa Sound
Bayous Hoffman,Woodlawn
Bayous Texar, Grande
Perdido Bay, Perdido River

Eighteen locations were targeted over the region providing 56 samples containing 170 fish. All samples were composites of 2 to 4 fish with at least three composites per location in nearly all cases, except four fish from the I-10 demolition blast on the Escambia Bay Bridge that were analyzed individually.

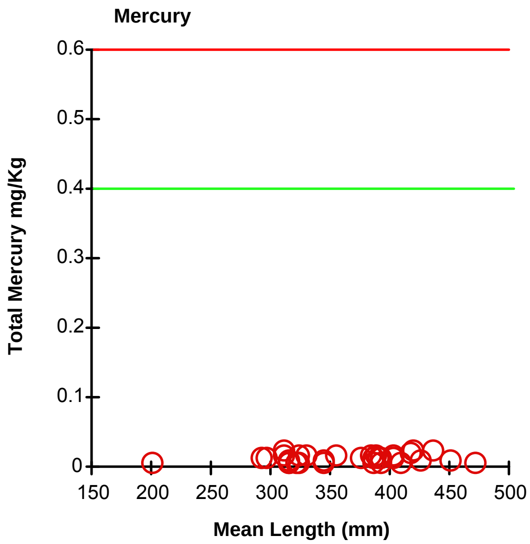
Mercury content was very low in all mullet tested.

Mullet contained the highest PCB and Dioxins/Furans concentrations of any fish sampled during this study, especially those fish collected from known PCB contaminated areas. Thirty of 56 samples exceeded the US EPA screening value for total PCBs, and 45 out of 56 samples exceeded the US EPA combined PCB and Dioxins/Furans TEQ screening value. Thirty-two samples exceeded the TEQ value for Dioxins/Furans alone, and 29 samples exceeded the TEQ threshold for PCBs alone.

Samples of skin-on fillets had twice the PCB load of skinless fillets, but the toxicity (TEQ) was higher for the skinless fillet.

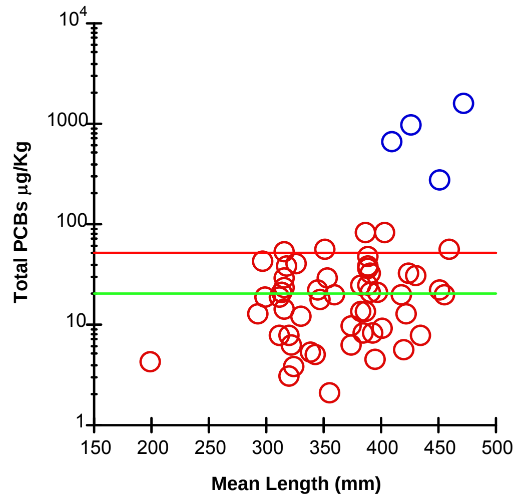
Locations with samples below the US EPA recreational consumption screening value for total PCBs and the combined PCB and Dioxins/Furans TEQ screening value were:
Yellow River, 2 of 3 samples
Bayou Texar, 1 of 3 samples
East Bay, 3 of 3 samples

**Mercury Content**

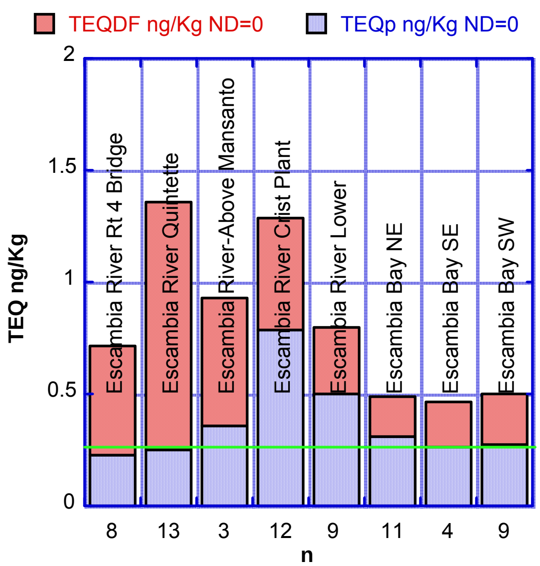



Red line: State of Florida action limit at 0.6 mg/kg. Green line: US EPA recreational consumption action limit at 0.4 mg/kg

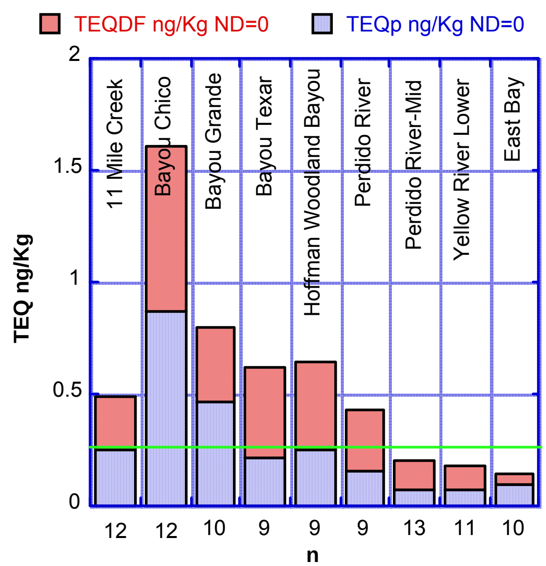
**PCB content**



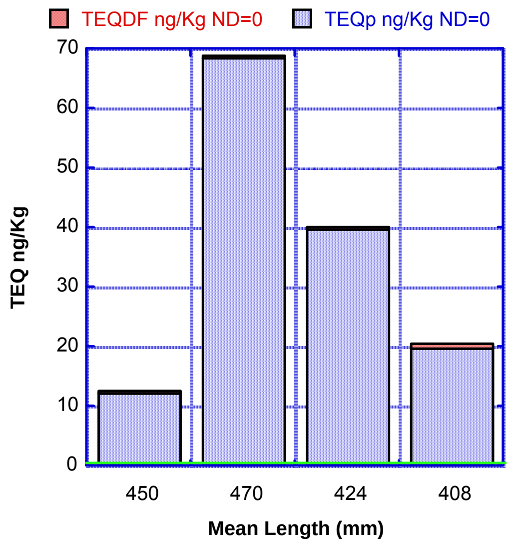

State of Florida limit 50 µg/kg (red line). US EPA recreational limit 20 µg/kg (green line). Note log scale on y-axis. Blue symbols I-10 Bridge, Esc. Bay




Toxicity of Dioxins Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in Mullet within Escambia Bay except for I-10 bridge collections. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values.



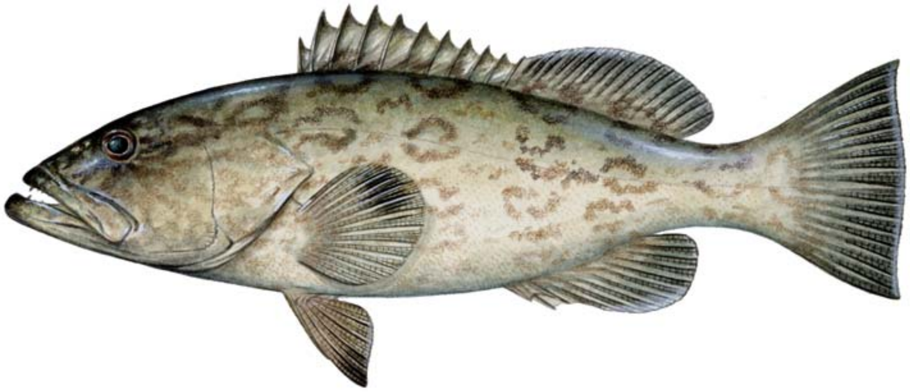

$TEQ_{DF}$ and $TEQ_P$ in Mullet in NW Florida waters except Escambia Bay. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values..




$TEQ_{DF}$ and $TEQ_P$ in Mullet from the I-10 bridge in Esc. Bay. US EPA recreational consumption limit 0.256 ng/kg (green line). State of Florida does not have an official action limit established for TEQ values.

| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | Mean Age | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 Mile Creek | 4 | 314 | 351.8 | | 2.1 | 2.10 | **0.3270** | **0.2712** | **0.5982** | **21.188** | | 30.456 | -87.377 |
| 11 Mile Creek | 4 | 329 | 415.3 | | 2.5 | 2.10 | **0.3490** | **0.2913** | **0.6403** | 12.400 | 0.018 | 30.456 | -87.377 |
| 11 Mile Creek | 4 | 382 | 623.3 | | 3.0 | 1.50 | 0.1480 | 0.1717 | **0.3197** | 14.027 | 0.018 | 30.456 | -87.377 |
| Bayou Chico | 4 | 312 | 311.5 | | 1.5 | | 0.3420 | **0.5009** | **0.8429** | **21.269** | | 30.404 | -87.255 |
| Bayou Chico | 4 | 314 | 332.5 | | 1.7 | 0.40 | **1.2398** | **0.9612** | **2.2010** | **29.392** | 0.008 | 30.404 | -87.255 |
| Bayou Chico | 4 | 326 | 328.8 | | 2.4 | 1.10 | **0.6560** | **1.1278** | **1.7838** | **40.800** | | 30.404 | -87.255 |
| Bayou Grande | 4 | 314 | 370.8 | | 2.2 | 0.30 | **0.5299** | **0.3020** | **0.8319** | 14.500 | 0.0083 | 30.372 | -87.297 |
| Bayou Grande | 3 | 344 | 323.3 | | 2.3 | 0.90 | **0.3600** | **0.5792** | **0.9392** | **22.103** | 0.008 | 30.372 | -87.297 |
| Bayou Grande | 3 | 358 | 431.0 | | 2.5 | 0.50 | 0.1230 | **0.5139** | **0.6369** | **20.351** | | 30.372 | -87.297 |
| Bayou Texar | 3 | 373 | 496.0 | | 1.8 | 1.00 | 0.0110 | 0.0219 | 0.0329 | 9.859 | | 30.439 | -87.188 |
| Bayou Texar | 3 | 385 | 563.7 | | 2.0 | 0.50 | 0.0840 | 0.2389 | **0.3229** | 14.113 | 0.010 | 30.439 | -87.188 |
| Bayou Texar | 3 | 390 | 493.3 | | 1.7 | 1.30 | **1.1360** | **0.3630** | **1.4990** | **21.500** | 0.0096 | 30.439 | -87.188 |
| East Bay | 4 | 419 | 617.5 | | 3.1 | 1.10 | 0.0000 | 0.2119 | 0.2119 | 5.800 | 0.026 | 30.450 | -86.980 |
| East Bay | 3 | 422 | 633.3 | | 3.2 | 2.80 | 0.0350 | 0.0564 | 0.0914 | 13.100 | | 30.450 | -86.980 |
| East Bay | 3 | 434 | 693.3 | | 3.5 | 0.60 | 0.0980 | 0.0203 | 0.1183 | 7.759 | 0.026 | 30.450 | -86.980 |
| Esc. Bay I-10 Bridge | 1 | 408 | 750.0 | F | | 4.40 | **1.0701** | **19.6102** | **20.6803** | **678.000** | 0.0095 | 30.519 | -87.143 |
| Esc. Bay I-10 Bridge | 1 | 424 | 750.0 | F | | 2.20 | **0.5219** | **39.5867** | **40.1086** | **1003.255** | 0.011 | 30.519 | -87.143 |
| Esc. Bay I-10 Bridge | 1 | 450 | 930.0 | F | | 3.90 | **0.4382** | **12.1610** | **12.5992** | **284.000** | 0.013 | 30.519 | -87.143 |
| Esc. Bay I-10 Bridge | 1 | 470 | 1010.0 | F | | 3.30 | **0.4668** | **68.5075** | **68.9743** | **1580.000** | 0.0099 | 30.519 | -87.143 |
| Escambia Bay NE | 4 | 387 | 607.5 | | 2.6 | 1.10 | **0.3030** | 0.0834 | **0.3864** | **36.724** | | 30.569 | -87.165 |
| Escambia Bay NE | 4 | 388 | 562.5 | | 2.7 | 1.70 | 0.1640 | **0.7789** | **0.9429** | **24.600** | 0.018 | 30.569 | -87.165 |
| Escambia Bay NE | 3 | 424 | 716.7 | | 4.0 | 2.10 | 0.0670 | 0.0662 | **0.1332** | **33.600** | | 30.569 | -87.165 |
| Escambia River Lower | 3 | 381 | 602.3 | F | 2.4 | 2.00 | **0.3750** | 0.0577 | **0.4327** | **24.852** | | 30.533 | -87.169 |
| Escambia River Lower | 3 | 388 | 675.0 | F | 2.7 | 2.20 | 0.0480 | **0.5199** | **0.5679** | **48.605** | 0.017 | 30.533 | -87.169 |
| Escambia River Lower | 3 | 402 | 763.3 | F | 4.0 | 1.90 | **0.4420** | **0.9390** | **1.3810** | **84.000** | 0.017 | 30.533 | -87.169 |
| Escambia Bay SE | 2 | 392 | 564.0 | | | 0.60 | **0.3630** | 0.2393 | **0.6023** | 8.570 | 0.014 | 30.465 | -87.151 |
| Escambia Bay SE | 2 | 401 | 563.5 | | | 0.70 | 0.0463 | **0.2750** | **0.3213** | 9.140 | 0.021 | 30.465 | -87.151 |
| Escambia Bay SW | 3 | 387 | 556.7 | | 2.9 | 1.90 | **0.4930** | 0.0787 | **0.5717** | **38.699** | | 30.494 | -87.113 |
| Escambia Bay SW | 3 | 395 | 566.7 | | 3.3 | 1.30 | 0.0310 | **0.4469** | **0.4779** | **21.200** | | 30.494 | -87.113 |
| Escambia Bay SW | 3 | 417 | 633.3 | | 3.0 | 1.40 | 0.1490 | **0.3064** | **0.4554** | **20.100** | 0.024 | 30.494 | -87.113 |
| Esc. River Crist Plant | 3 | 316 | 288.1 | | 1.3 | 1.10 | 0.0910 | **0.3508** | **0.4418** | **39.000** | | 30.554 | -87.212 |
| Esc. River Crist Plant | 3 | 350 | 374.6 | F | 1.3 | 1.00 | 0.2160 | **0.7479** | **0.9639** | **57.700** | | 30.554 | -87.212 |
| Esc. River Crist Plant | 3 | 385 | 516.7 | M | 2.0 | 1.20 | **1.0959** | **1.2081** | **2.3040** | **85.100** | | 30.554 | -87.212 |
| Esc. River Crist Plant | 3 | 457 | 776.7 | F | 3.3 | 1.70 | **0.5802** | **0.8412** | **1.4214** | **56.700** | | 30.554 | -87.212 |
| Escambia River Mid (above Mansanto) | 3 | 450 | 1160.0 | F | 5.0 | 6.50 | **0.5750** | **0.3556** | **0.9306** | **22.480** | | | |
| Escambia River Quintette Bridge | 4 | 346 | 427.5 | F | 1.0 | 1.00 | **0.3990** | 0.1675 | **0.5665** | 18.600 | | 30.670 | -87.267 |
| Escambia River Quintette Bridge | 3 | 390 | 620.0 | | 1.0 | 2.80 | **1.6293** | **0.5613** | **2.1906** | **33.300** | | 30.670 | -87.267 |
| Escambia River Quintette Bridge | 3 | 430 | 760.0 | F | 1.3 | 3.60 | **1.4059** | 0.0410 | **1.4469** | **32.100** | | 30.670 | -87.267 |
| Escambia River Quintette Bridge | 3 | 455 | 856.7 | | 3.7 | 1.10 | **0.9838** | 0.2267 | **1.2105** | **20.400** | | 30.670 | -87.267 |

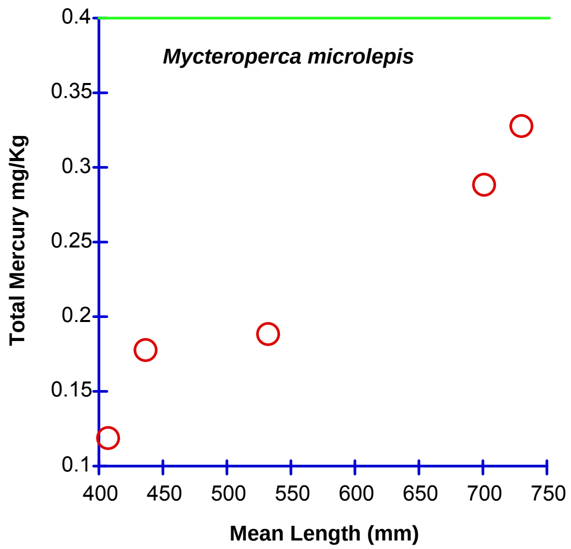
| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | Mean Age | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Escambia River Rt 4 Bridge | 2 | 199 | 186.5 | F | 2.0 | 0.90 | **0.5365** | 0.0253 | **0.5618** | 4.390 | 0.008 | 30.967 | 87.234 |
| Escambia River Rt 4 Bridge | 3 | 295 | 660.0 | F | 2.7 | 3.20 | 0.1655 | **0.4048** | **0.5703** | **42.600** | 0.017 | 30.967 | 87.234 |
| Escambia River Rt 4 Bridge | 3 | 353 | 946.7 | F | 3.8 | 4.70 | **0.7760** | 0.2420 | **1.0180** | **29.800** | 0.021 | 30.967 | 87.234 |
| Perdido River | 3 | 310 | 321.7 | | 1.5 | 1.70 | **0.3060** | 0.1674 | **0.4734** | 8.050 | 0.021 | 30.460 | -87.412 |
| Perdido River | 3 | 318 | 320.3 | | 2.2 | 2.80 | **0.3800** | 0.1999 | **0.5799** | 8.087 | | 30.460 | -87.412 |
| Perdido River | 3 | 322 | 311.0 | | 2.0 | 1.50 | 0.1450 | 0.0823 | 0.2273 | 3.843 | 0.021 | 30.460 | -87.412 |
| Perdido River Lower | 5 | 320 | 319.0 | | 2.0 | 1.00 | 0.1130 | 0.0982 | 0.2112 | 3.110 | 0.0097 | 30.530 | -87.447 |
| Perdido River Lower | 4 | 321 | 315.8 | | 2.0 | 1.30 | 0.1630 | 0.0090 | 0.1720 | 6.363 | 0.010 | 30.530 | -87.447 |
| Perdido River Mid | 4 | 338 | 358.5 | | 2.0 | 2.10 | 0.1240 | 0.1078 | 0.2318 | 5.283 | | 30.530 | -87.447 |
| Yellow River Lower | 4 | 342 | 382.5 | | 2.0 | 1.40 | 0.2170 | 0.1209 | **0.3379** | 5.050 | 0.012 | 30.536 | -87.020 |
| Yellow River Lower | 4 | 355 | 425.3 | | 1.8 | 1.00 | 0.0000 | 0.0038 | 0.0038 | 2.080 | | 30.536 | -87.020 |
| Yellow River Lower | 3 | 394 | 552.0 | | 3.5 | 1.30 | 0.1280 | 0.0721 | 0.2001 | 4.517 | | 30.536 | -87.020 |
| Hoffman Woodland Bayou | 2 | 374 | 457.0 | | | 0.80 | **0.5920** | 0.1312 | **0.7232** | 6.300 | 0.014 | 30.365 | -87.179 |
| Hoffman Woodland Bayou | 2 | 384 | 493.0 | | | 0.70 | **0.3230** | 0.1546 | **0.4776** | 8.310 | 0.014 | 30.365 | -87.179 |
| Hoffman Woodland Bayou | 2 | 292 | 205.5 | | | | | | | 12.705 | 0.014 | 30.365 | -87.179 |
| Hoffman Woodland Bayou | 2 | 297 | 229.5 | | | 4.20 | 0.0687 | **0.3309** | **0.3996** | 19.445 | | 30.365 | -87.179 |
| Hoffman Woodland Bayou | 3 | 311 | 321.5 | | 1.3 | 4.80 | **0.5510** | **0.3975** | **0.9485** | 19.000 | 0.027 | 30.365 | -87.179 |



**Gag Grouper**
*Mycteroperca microlepis*

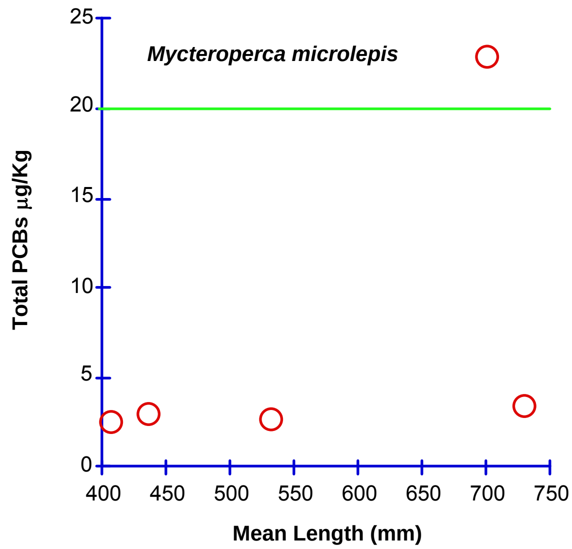
**Sample Locations:** Offshore

## Mercury Content

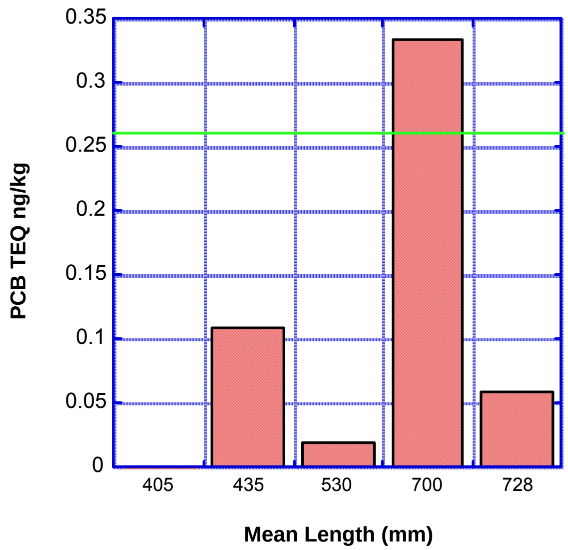



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content

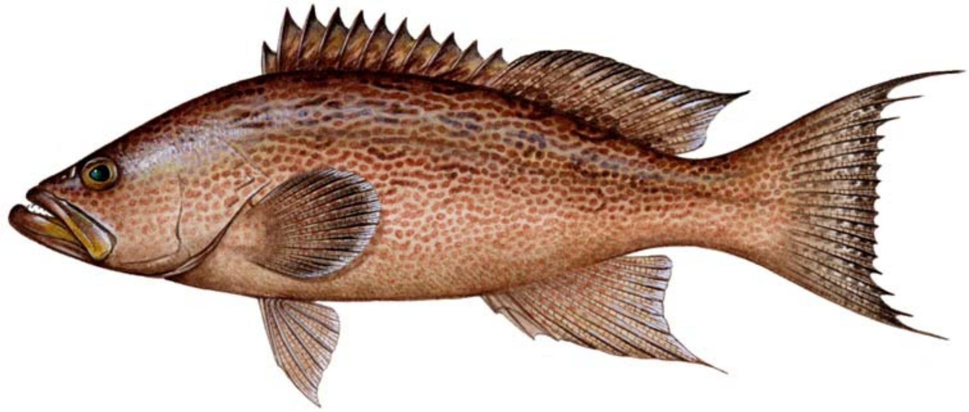



Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.




Toxicity of PCBs ($TEQ_P$) in Scamp from offshore Pensacola, FL. Two samples were close to zero. The US EPA recreational consumption action limit is indicated by the green line at 0.256 ng/kg.

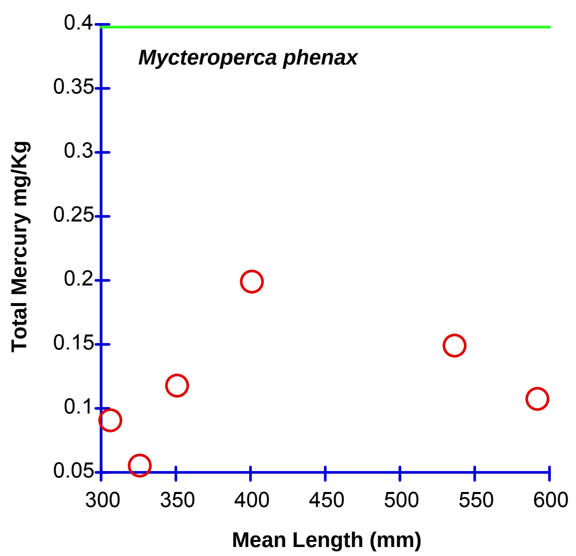
| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs ug/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|
| Offshore midshelf | 1 | 435 | 840.0 | 0.10 | 0.1095 | 2.994 | 0.18 | 30.1849 | -87.2367 |
| Offshore midshelf | 1 | 700 | 4670.0 | 0.70 | **0.3335** | **22.980** | 0.29 | 30.1963 | -87.2385 |
| Offshore outer shelf | 1 | 405 | 1230.0 | 0.20 | 0.0012 | 2.62 | 0.12 | 29.8472 | -87.3042 |
| Offshore outer shelf | 1 | 530 | 1890.0 | 0.10 | 0.0197 | 2.792 | 0.19 | 30.0672 | -87.0922 |
| Offshore outer shelf | 1 | 728 | 8960.0 | 0.80 | 0.0591 | 3.504 | 0.33 | 29.7167 | -87.3167 |



# **Scamp Grouper**
*Mycteroperca phenax*

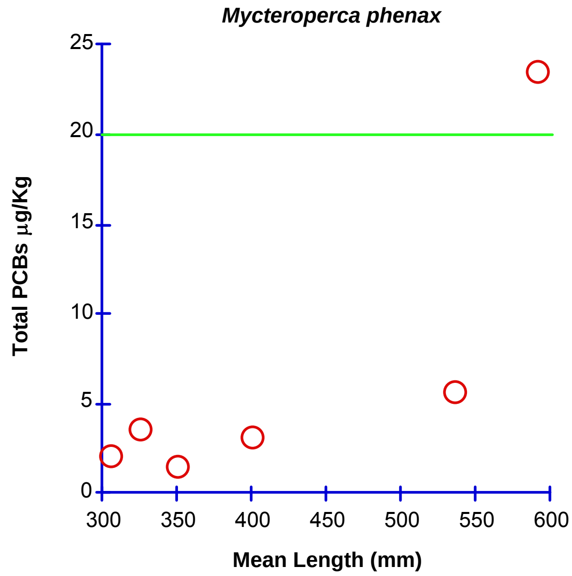
**Sampling Locations:** Offshore

**<u>Mercury Content</u>**

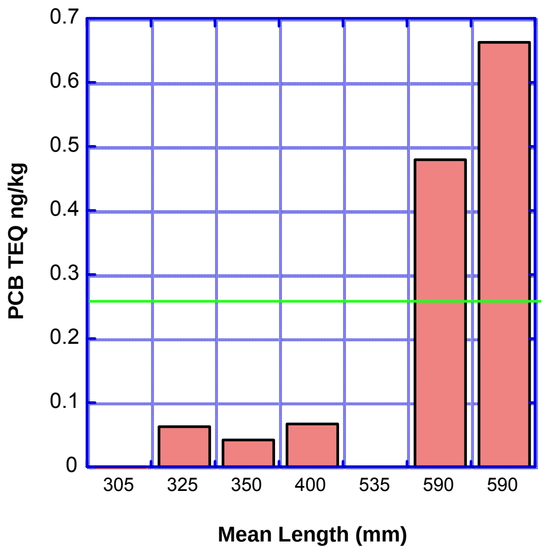



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

**<u>PCB Content</u>**




Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.

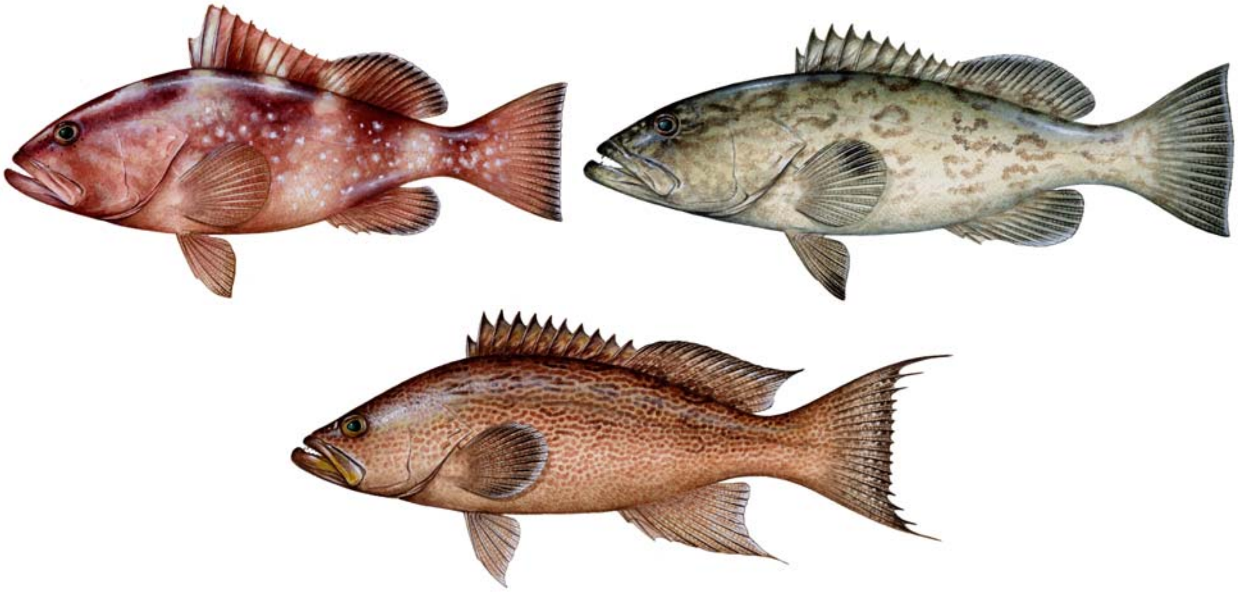



Toxicity of PCBs ($TEQ_P$) in Scamp from offshore Pensacola, FL. Two samples were close to zero. The US EPA recreational consumption action limit is indicated by the green line at 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | 1 | 305 | 570.0 | 0.10 | 0.0004 | 2.08 | 0.092 | 29.8472 | -87.3042 |
| Offshore outer shelf | 1 | 325 | 820.0 | 0.50 | 0.0641 | 3.646 | 0.058 | 29.3000 | -88.0167 |
| Offshore outer shelf | 1 | 350 | 90.0 | 0.10 | 0.0422 | 1.580 | 0.12 | 29.8472 | -87.3042 |
| Offshore outer shelf | 1 | 400 | 570.0 | 2.20 | 0.0679 | 3.160 | 0.2 | 29.8472 | -87.3042 |
| Offshore outer shelf | 1 | 535 | 2070.0 | 0.60 | | 5.668 | 0.15 | 29.4333 | -87.7167 |
| Offshore outer shelf | 1 | 590 | 5250.0 | 2.10 | **0.6646** | **32.066** | 0.098 | 29.1833 | -88.1833 |
| Offshore outer shelf | 1 | 590 | 5250.0 | 2.20 | **0.4822** | **23.600** | 0.11 | 29.1833 | -88.1833 |

## Red, Gag, & Scamp Groupers

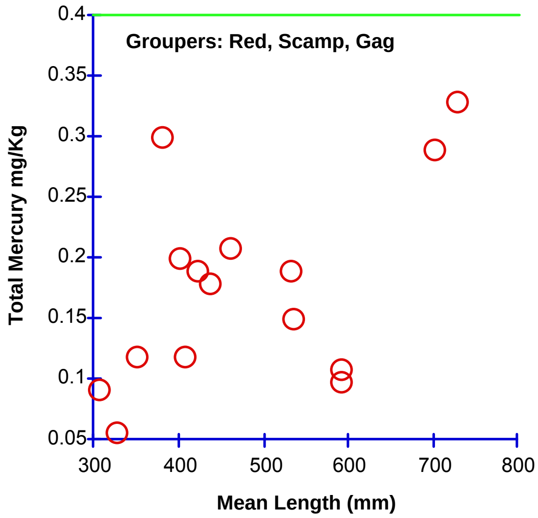
*Epinephalus morio, Mycteroperca microlepis, Mycteroperca phenax*



**Sampling Location**: Offshore

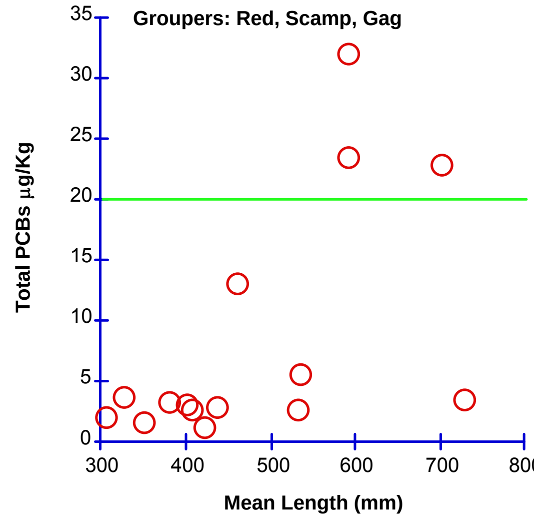
Fifteen groupers were sampled from offshore reefs. These fishes show a tendency for bioaccumulation with age for both mercury and PCBs.   No samples exceeded the US EPA screening value for mercury, although three samples exceeded the screening value for total PCBs, and four samples exceed the TEQ value for PCBs alone (Dioxin/Furans were not analyzed in these fish).

## Mercury Content

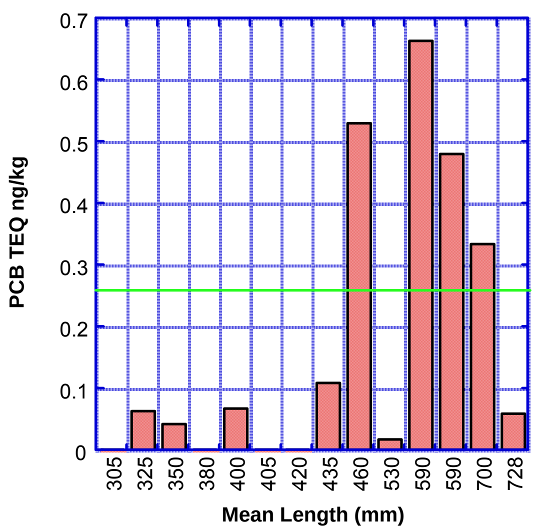



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

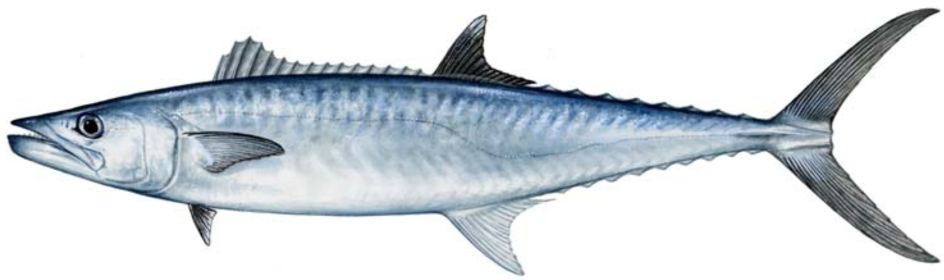
## PCB Content




Green line: US EPA recreational consumption action limit at 20 µg/kg




Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

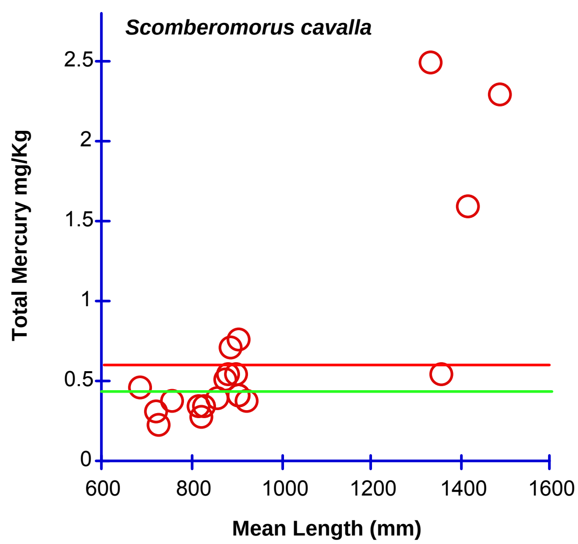


## King Mackerel
*Scomberomorus cavalla*

**Sample locations:** Offshore

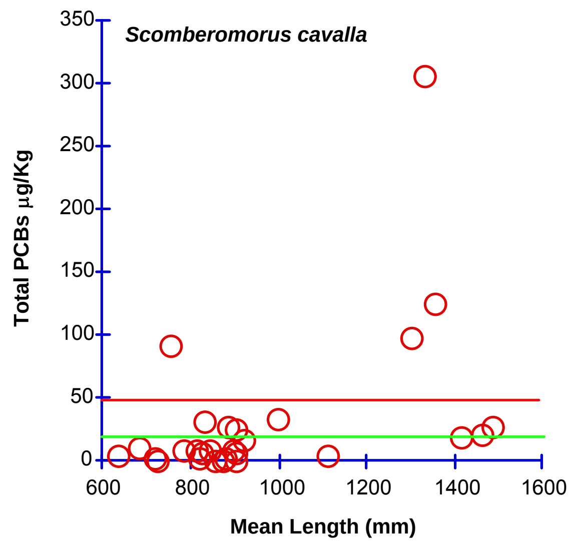
Twenty-eight fish were sampled from offshore Pensacola. Both PCBs and Hg accumulate with age in this species. Mercury content was high in these fish, and an existing consumption advisory exists based on the mercury content of larger specimens (>32"), which agrees with the recorded sizes of those fishes in this study exceeding the US EPA screening value. PCB content also exceeded the US EPA screening value at about the same size. The highest PCB loads of any offshore fish sampled were recorded for this species (92.5 µg/kg). Combined Dioxins/Furans and PCB TEQ values exceeded the US EPA screening value in 11 of 22 fish for which this data was available.

**Mercury Content**

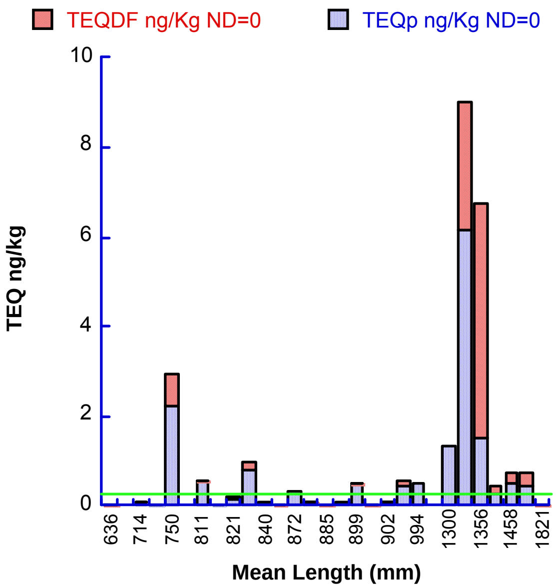



Green line: US EPA recreational consumption action limit at 0.40 mg/kg. Red line: State of Florida threshold for limited consumption at 0.60 mg/kg.

**PCB Content**

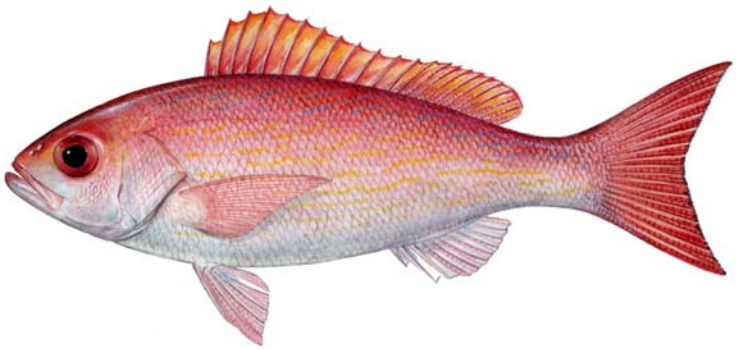



Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.



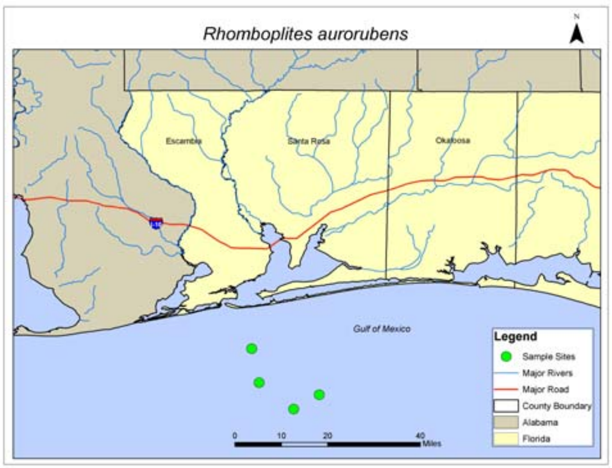

Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

| Location | Mean Length (mm) | Mean Weight (g) | Sex | Mean Age | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| Nearshore 3 Barges | 714 | 1740.0 | F | | 0.10 | 0.0032 | 0.0610 | 0.0642 | 3.030 | 0.32 | 30.289 | -87.220 |
| Nearshore 3 Barges | 721 | 1700.0 | F | | 0.10 | | 0.0005 | | 1.430 | 0.24 | 30.289 | -87.220 |
| Nearshore 3 Barges | 811 | 2790.0 | F | 2.0 | 0.10 | 0.0178 | **0.5429** | **0.5607** | 9.610 | 0.36 | 30.289 | -87.220 |
| Nearshore 3 Barges | 817 | 2860.0 | F | 3.0 | 0.80 | 0.0000 | 0.0462 | 0.0462 | 3.100 | 0.29 | 30.289 | -87.220 |
| Nearshore 3 Barges | 821 | 2650.0 | F | | 0.60 | 0.0832 | 0.1415 | 0.2247 | 7.910 | 0.35 | 30.289 | -87.220 |
| Nearshore 3 Barges | 880 | 3590.0 | F | | 0.30 | 0.0016 | 0.1033 | 0.1049 | 2.960 | **0.55** | 30.289 | -87.220 |
| Nearshore 3 Barges | 885 | 3140.0 | F | 2.0 | 0.10 | 0.0090 | | 0.0090 | **27.700** | **0.73** | 30.289 | -87.220 |
| Nearshore 3 Barges | 893 | 4180.0 | M | 2.0 | 0.20 | 0.0000 | 0.0804 | 0.0804 | 8.460 | **0.56** | 30.289 | -87.220 |
| Nearshore 3 Barges | 899 | 3910.0 | F | 2.0 | 0.30 | 0.0141 | **0.5034** | **0.5175** | **25.900** | **0.42** | 30.289 | -87.220 |
| Nearshore 3 Barges | 994 | 5300.0 | M | 9.0 | 0.10 | | **0.4776** | | **34.100** | | 30.289 | -87.220 |
| Nearshore Paradise Hole | 636 | 1260.0 | M | 2.0 | 0.10 | 0.0093 | 0.0018 | 0.0111 | 5.120 | | 30.216 | -87.446 |
| Nearshore Paradise Hole | 681 | 1450.0 | NT | | 0.50 | | | | 11.900 | **0.47** | 30.216 | -87.446 |
| Nearshore Paradise Hole | 840 | 2930.0 | F | 3.0 | 0.10 | | 0.1058 | | 8.840 | | 30.216 | -87.446 |
| Nearshore Paradise Hole | 855 | 3170.0 | F | 3.0 | 0.20 | 0.0081 | 0.0008 | 0.0089 | 1.860 | **0.41** | 30.216 | -87.446 |
| Nearshore Paradise Hole | 872 | 2610.0 | F | 3.0 | 0.50 | 0.0000 | **0.3362** | **0.3362** | 1.410 | **0.52** | 30.216 | -87.446 |
| Offshore outer shelf | 750 | 5090.0 | M | | 6.00 | **0.7228** | 2.2172 | **2.9400** | **92.459** | 0.39 | 29.847 | -87.304 |
| Offshore outer shelf | 900 | 3680.0 | F | | 0.20 | 0.0013 | 0.0008 | 0.0021 | 1.680 | **0.77** | | |
| Offshore outer shelf | 902 | 3480.0 | F | | 0.10 | 0.0069 | 0.0639 | 0.0708 | 6.630 | **0.43** | | |
| Offshore outer shelf | 919 | 3870.0 | F | | 0.30 | 0.1255 | **0.4262** | | 17.700 | 0.39 | | |
| Offshore outer shelf | 1109 | 7440.0 | F | 11.0 | 0.80 | | | | 4.980 | | | |
| Offshore outer shelf | 1300 | 1255.0 | F | 13.0 | 0.50 | | **1.3320** | | **98.300** | | | |
| Offshore outer shelf | 1330 | 15000.0 | F | | 8.00 | **2.8670** | **6.1700** | **9.0370** | 307 | **2.5** | | |
| Offshore outer shelf | 1356 | 14840.0 | F | | 5.30 | **5.2370** | **1.4995** | **6.7365** | 125 | **0.55** | | |
| Offshore outer shelf | 1413 | 17540.0 | F | | 0.40 | 0.2077 | **0.2560** | **0.4637** | 18.8 | **1.6** | | |
| Offshore outer shelf | 1458 | 23500.0 | F | | 0.30 | **0.2606** | **0.4977** | **0.7583** | **22.7** | **3.6** | | |
| Offshore outer shelf | 1484 | 18080.0 | F | | 0.50 | **0.2946** | **0.4368** | **0.7314** | **27.4** | **2.3** | | |
| Offshore outer shelf | 1821 | 28360.0 | F | | 0.10 | 0.0055 | 0.0028 | 0.0083 | 2.82 | **4.9** | | |
| Pensacola Beach Pier | 780 | 3855.0 | F | | 0.20 | | | | 8.412 | | 30.330 | -87.141 |
| Pensacola Beach Pier | 830 | 4820.0 | F | | 6.40 | 0.2081 | **0.7822** | **0.9903** | **32.185** | | 30.330 | -87.141 |



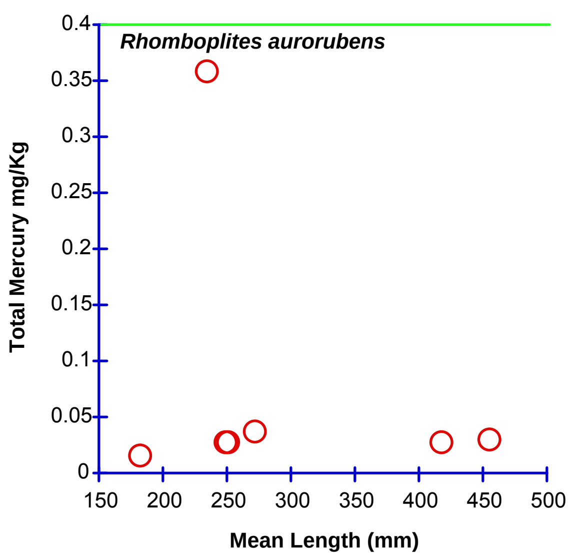
## Mingo Snapper
*Rhomboplites aurorubens*

## Sample Locations



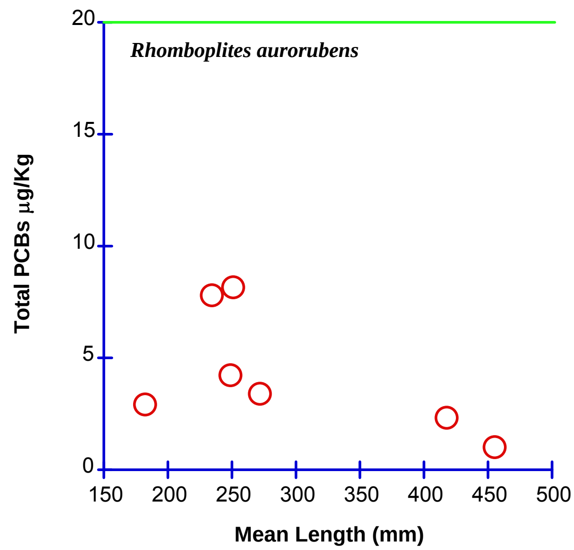

Specimens were obtained over offshore reefs representing 8 samples comprised of 20 fish, with 6 samples as individual specimens. TEQ values, PCBs and mercury content were all low in sampled fish.

## Mercury Content

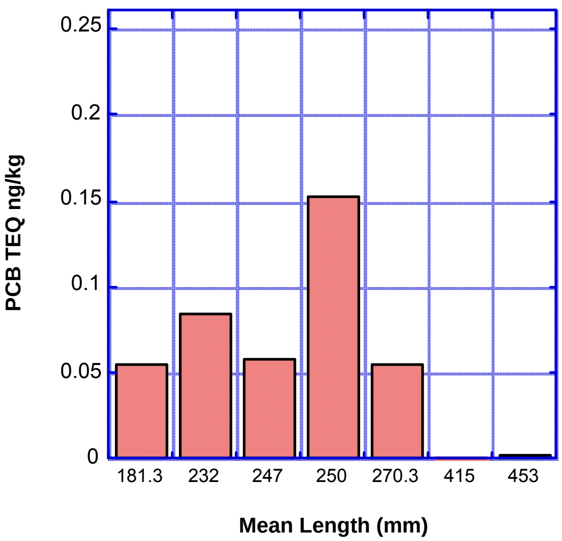



Green line: US EPA recreational consumption action limit at 0.4 mg/kg

## PCB Content

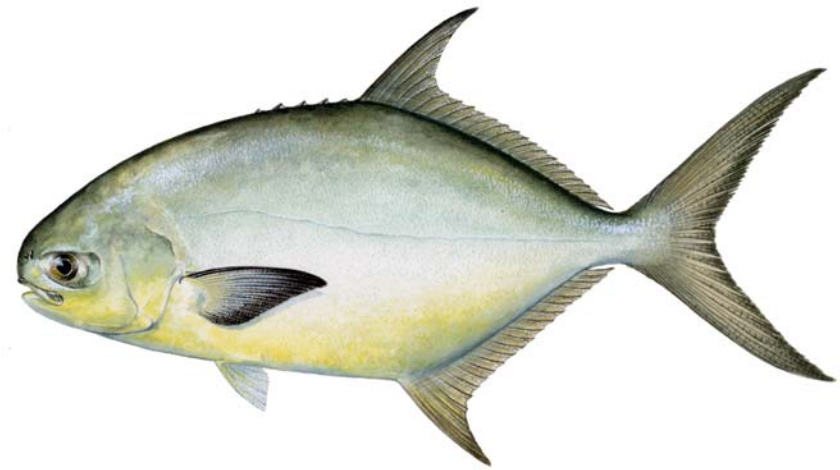



Green line: US EPA recreational consumption action limit at 20 µg/kg




Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ is 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|
| Offshore midshelf | 3 | 270 | 333.7 | 1.50 | 0.0547 | 3.47 | 0.039 | 30.188 | -87.217 |
| Offshore midshelf reef permit zone | 1 | 173 | 72.1 | | | | | 30.081 | -87.194 |
| Offshore midshelf reef permit zone | 11 | 181 | 86.9 | 1.50 | 0.0548 | 2.95 | 0.017 | 30.081 | -87.194 |
| Offshore outer shelf | 1 | 232 | 380.0 | 1.58 | 0.0836 | 7.820 | 0.36 | 30.043 | -87.006 |
| Offshore outer shelf | 1 | 247 | 460.0 | 1.01 | 0.0573 | 4.2746 | 0.029 | 30.043 | -87.006 |
| Offshore outer shelf | 1 | 250 | 430.0 | 1.48 | 0.1524 | 8.260 | 0.029 | 30.043 | -87.006 |
| Offshore outer shelf | 1 | 415 | 980.0 | 0.80 | 0.0003 | 2.32 | 0.03 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 453 | 1180.0 | 1.00 | 0.0020 | 1.050 | 0.032 | 29.998 | -87.086 |

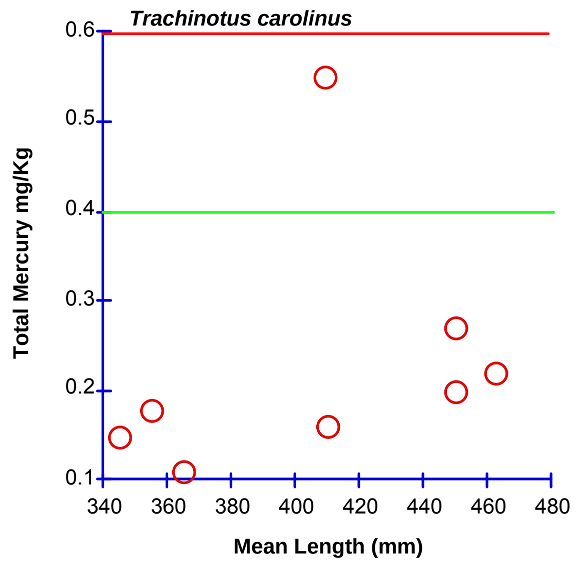


**Pompano**
*Trachinotus carolinus*

**Sample locations:** Santa Rosa Island Surf

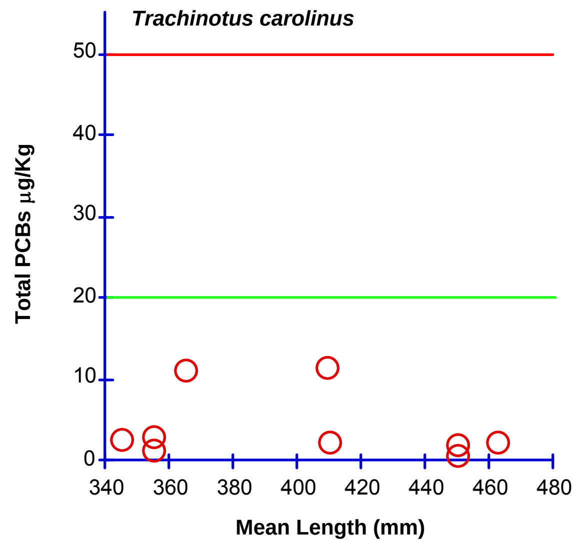
Nine fish were collected from Santa Rosa Island Surf and analyzed as individuals. Mercury accumulation with size was apparent, but only one mid-sized fish of nine samples exceeded the US EPA screening value. None of the PCB concentrations were above the US EPA screening value, and higher concentrations were found in smaller fish, consistent with estuarine utilization by juveniles in this species. The fish with the two highest PCB concentrations also had high Dioxins/Furans, and the TEQ values for these fish exceeded the US EPA TEQ screening value for recreational fisher consumption.

**Mercury Content**

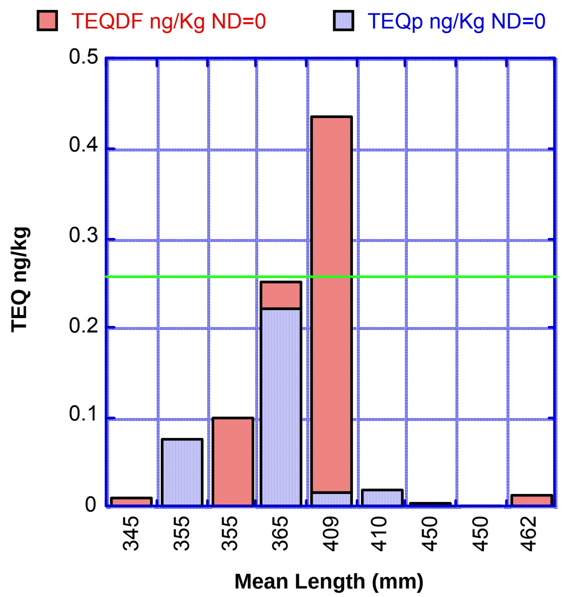



Green line: US EPA recreational consumption action limit at 0.40 mg/kg. Red line: State of Florida action limit at 0.6 mg/kg..

**PCB Content**

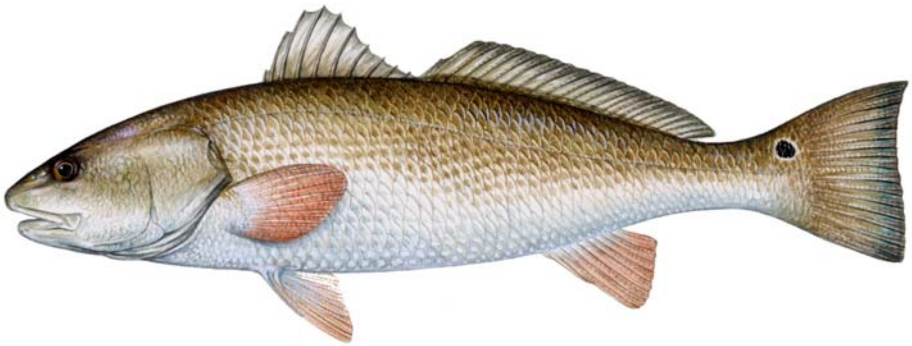



Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore. Red line: State of Florida action limit at 50 µg/kg



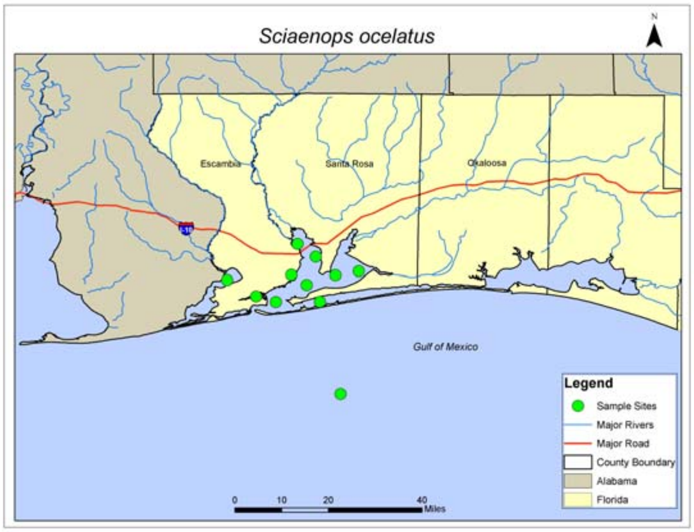

Toxicity of Dioxins Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in Pompano from Santa Rosa Island Surf. The green line is the US EPA recreational consumption action limit at 0.256 ng/k

| Location | n | Mean Lgth (mm) | Mean Wght (g) | Sex | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_P$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Santa Rosa Island surf | 1 | 345 | 490.0 | F | 0.40 | 0.0081 | 0.0014 | 0.0095 | 2.850 | 0.15 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 355 | 520.0 | F | 0.30 | 0.0000 | 0.0748 | 0.0748 | 3.030 | 0.18 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 355 | 510.0 | F | 1.50 | 0.1000 | 0.0004 | 0.1004 | 0.59 | 0.18 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 365 | 610.0 | F | 2.30 | 0.0280 | 0.2228 | 0.2508 | 11.400 | 0.11 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 409 | 500.0 | M | 0.40 | **0.4206** | 0.0162 | **0.4368** | 11.50 | **0.55** | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 410 | 870.0 | F | 2.50 | 0.0000 | 0.0192 | 0.0192 | 2.560 | 0.16 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 450 | 1090.0 | F | 0.30 | 0.0000 | 0.0038 | 0.0038 | 2.050 | 0.27 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 450 | 960.0 | F | 0.10 | 0.0000 | 0.0002 | 0.0002 | 0.746 | 0.2 | 30.349 | -87.041 |
| Santa Rosa Island surf | 1 | 462 | 1180.0 | F | 0.10 | 0.0108 | 0.0010 | 0.0118 | 2.560 | 0.22 | 30.349 | -87.041 |



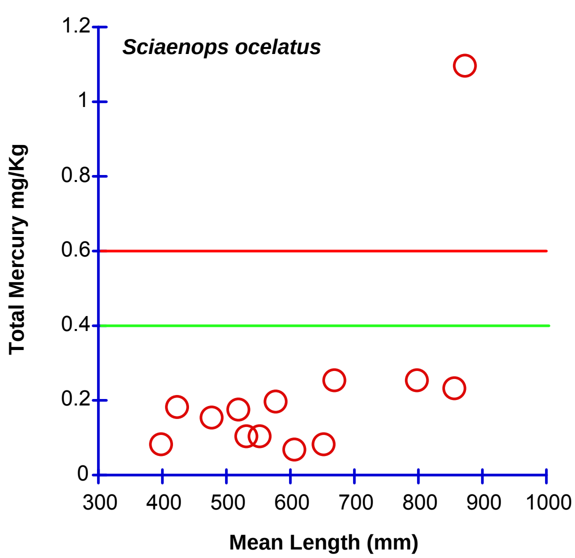
# Red Drum
## *Sciaenops ocelatus*

### Sample Locations



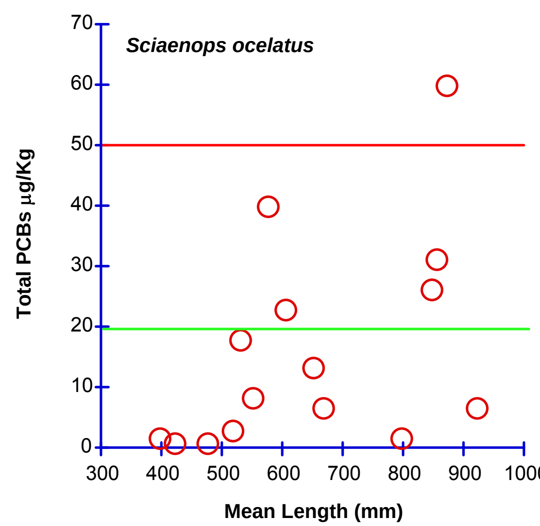

Fifteen samples including 28 fish from 10 locations were analyzed. With the exception of a single sample, mercury content increased slightly with size but was low in all samples. PCB content increased with size, with 5 samples over the US EPA screening value. Three fish had TEQ values that exceeded that US EPA screening value.

### Mercury Content

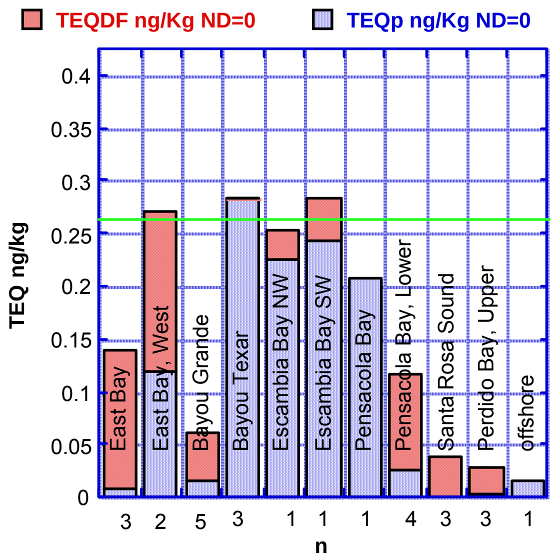



Red line: State of Florida action limit at 0.6 mg/kg. Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

### PCB Content




Red line: State of Florida action limit at 50 µg/kg Green line: US EPA recreational consumption action limit at 20 µg/kg

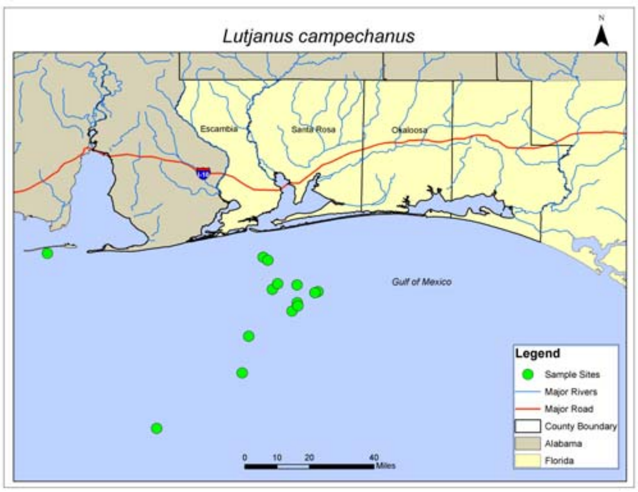



Toxicity of PCB molecules as a Toxic Equivalency Quotient (TEQ). The US EPA recreational consumption action limit for TEQ at 0.256 ng/kg is indicated by the green line.

| Location | n | Mean Lgth (mm) | Mean Wght (g) | Age | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pens. Bay | 1 | 845 | 6730 | 14.0 | | | 0.248 | | **26.400** | | 30.407 | -87.141 |
| Pens. Bay | 1 | 920 | 10510 | 15.0 | 0.10 | | 0.167 | | 6.690 | | 30.407 | -87.141 |
| Bayou Grande | 1 | 395 | 560.0 | 1.2 | 0.30 | 0.027 | 0.002 | 0.0286 | 1.729 | 0.090 | 30.372 | -87.297 |
| Bayou Grande | 4 | 526 | 1447.5 | 1.3 | 0.40 | 0.068 | 0.027 | 0.0946 | 18.233 | 0.110 | 30.372 | -87.297 |
| Bayou Texar | 3 | 550 | 1616.7 | 1.3 | 0.30 | 0.001 | **0.283** | **0.2840** | 8.310 | 0.110 | 30.439 | -87.188 |
| East Bay | 3 | 515 | 1250.0 | 1.0 | 0.30 | 0.131 | 0.008 | 0.1389 | 3.053 | 0.180 | 30.450 | -86.980 |
| East Bay, W | 1 | 667 | 3080.0 | 2.0 | 0.20 | 0.012 | 0.130 | 0.1422 | 6.897 | 0.260 | 30.437 | -87.052 |
| East Bay, W | 1 | 868 | 5060.0 | 8.0 | 0.20 | **0.288** | 0.110 | **0.3985** | **60.322** | 1.100 | 30.470 | -87.052 |
| Escambia Bay NW | 1 | 650 | 2730.0 | 3.0 | 0.10 | 0.027 | 0.226 | 0.2536 | 13.658 | 0.092 | 30.533 | -87.169 |
| Escambia Bay SW | 1 | 601 | 1810.0 | 2.0 | 0.20 | 0.041 | 0.242 | **0.2827** | **23.153** | 0.073 | 30.494 | -87.113 |
| Offshore | 1 | 796 | 4630.0 | | 0.30 | 0.000 | 0.015 | 0.0154 | 1.650 | 0.26 | 30.071 | -87.035 |
| Pensacola Bay, Lower | 3 | 473 | 976.7 | 1.0 | 0.20 | 0.020 | 0.001 | 0.0204 | 0.916 | 0.160 | 30.355 | -87.236 |
| Pensacola Bay, Lower | 1 | 853 | 6230.0 | 17.0 | 0.40 | 0.165 | 0.048 | 0.2134 | **31.314** | 0.240 | 30.355 | -87.236 |
| Perdido Bay Upper | 3 | 420 | 740.0 | 1.0 | 0.20 | 0.024 | 0.003 | 0.0271 | 1.150 | 0.190 | 30.420 | -87.387 |
| Santa Rosa Sound | 3 | 573 | 1250.0 | 2.0 | 0.20 | 0.038 | 0.000 | 0.0380 | **40.304** | 0.200 | 30.356 | -87.100 |

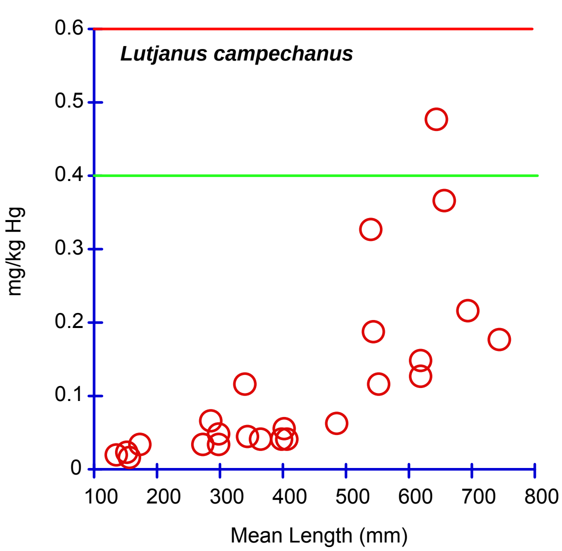
# Red Snapper
# *Lutjanus campechanus*

## Sample Locations



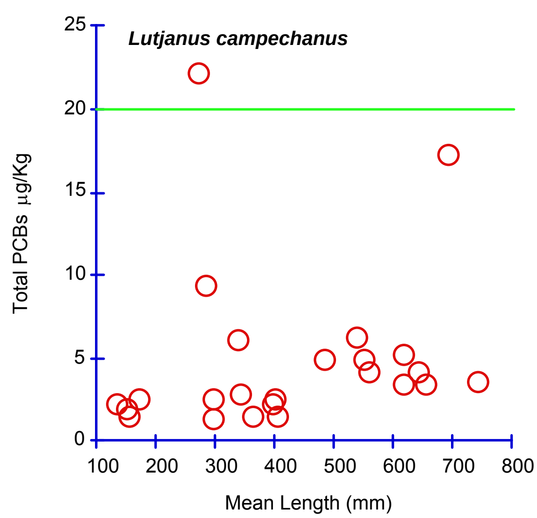

Forty-two fish in 24 samples were collected from offshore reefs, with smaller sized fish making up composites of 2 to 6 fish. Mercury content increased with size, with larger fish approaching the US EPA screening value and one fish exceeding it. PCB content was generally low with one larger fish close to the US EPA screening value and one smaller fish exceeding it. TEQ values followed a similar pattern, with only one smaller fish exceeding the screening value.

## Mercury Content

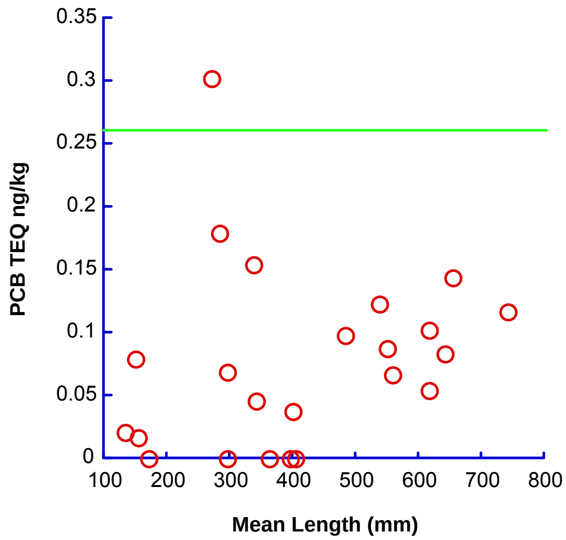



Red line: State of Florida action limit at 0.6 mg/kg. Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

## PCB Content




Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg.

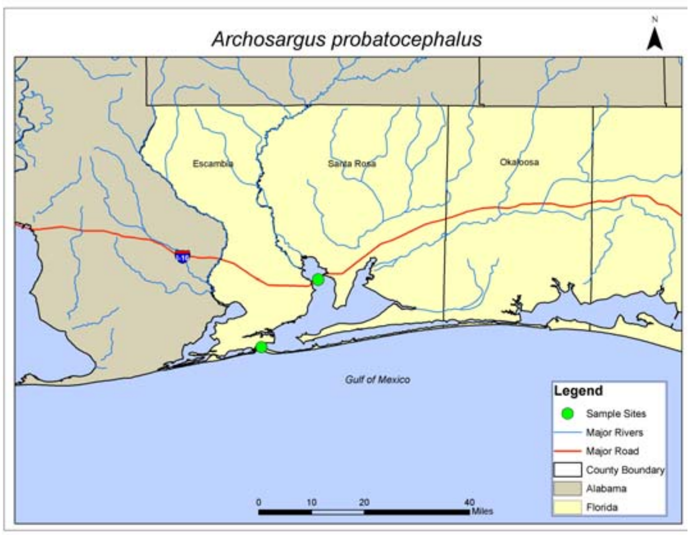



Toxicity of PCBs ($TEQ_P$) in Red Snapper from offshore Pensacola, FL. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipid | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|
| Inshore | 3 | 130 | 76.1 | 1.90 | 0.0215 | 2.23 | 0.023 | 30.208 | -87.120 |
| Inshore | 2 | 170 | 146.2 | 0.10 | 0.0011 | 2.64 | 0.037 | 30.208 | -87.120 |
| Offshore midshelf | 2 | 295 | 480.0 | 0.20 | 0.0686 | 2.631 | 0.05 | 30.189 | -87.218 |
| Offshore midshelf | 3 | 337 | 770.0 | 1.70 | 0.1550 | 6.13 | 0.12 | 30.189 | -87.218 |
| Offshore midshelf | 1 | 400 | 960.0 | 0.10 | 0.0380 | 2.600 | 0.06 | 30.202 | -87.239 |
| Offshore midshelf | 1 | 550 | 2300.0 | 0.20 | 0.0881 | 4.980 | 0.12 | 30.202 | -87.239 |
| Offshore midshelf | 1 | 613 | 3400.0 | 0.50 | 0.1030 | 5.315 | 0.13 | 30.202 | -87.239 |
| midshelf reef permit zone | 1 | 295 | 380.0 | 0.40 | 0.0006 | 1.477 | 0.036 | 30.083 | -87.174 |
| midshelf reef permit zone | 1 | 338 | 550.0 | 0.70 | 0.0475 | 2.86 | 0.049 | 30.083 | -87.174 |
| midshelf reef permit zone | 1 | 614 | 316.0 | 0.10 | 0.0559 | 3.505 | 0.15 | 30.058 | -87.198 |
| Offshore outer shelf | 4 | 151 | 122.9 | 0.60 | 0.0809 | 1.97 | 0.028 | 29.961 | -87.110 |
| Offshore outer shelf | 6 | 153 | 131.3 | 0.20 | 0.0171 | 1.597 | 0.021 | 29.984 | -87.084 |
| Offshore outer shelf | 1 | 270 | 620.0 | 0.13 | **0.3024** | **22.300** | 0.038 | 30.043 | -87.007 |
| Offshore outer shelf | 1 | 280 | 690.0 | 0.15 | 0.1801 | 9.370 | 0.07 | 30.043 | -87.007 |
| Offshore outer shelf | 1 | 362 | 652.8 | 0.70 | 0.0005 | 1.55 | 0.043 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 395 | 780.0 | 0.10 | 0.0012 | 2.35 | 0.044 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 401 | 920.0 | 0.10 | 0.0005 | 1.54 | 0.044 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 480 | 1520.0 | 1.50 | 0.0995 | 4.92 | 0.066 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 535 | 4480.0 | 0.40 | 0.1231 | 6.323 | 0.33 | 29.683 | -87.333 |
| Offshore outer shelf | 4 | 540 | 220.3 | | | | 0.19 | | |
| Offshore outer shelf | 1 | 558 | 2610.0 | 1.70 | 0.0676 | 4.23 | | 30.078 | -87.087 |
| Offshore outer shelf | 1 | 640 | 7600.0 | 0.40 | 0.0845 | 4.180 | **0.48** | 29.433 | -87.717 |
| Offshore outer shelf | 1 | 652 | 3690.0 | 0.10 | 0.1456 | 3.512 | 0.37 | 29.998 | -87.086 |
| Offshore outer shelf | 1 | 690 | 1068.0 | 0.50 | | 17.37 | 0.22 | 30.220 | -88.208 |
| Offshore outer shelf | 1 | 740 | 5680.0 | 0.00 | 0.1184 | 3.576 | 0.18 | 29.847 | -87.304 |

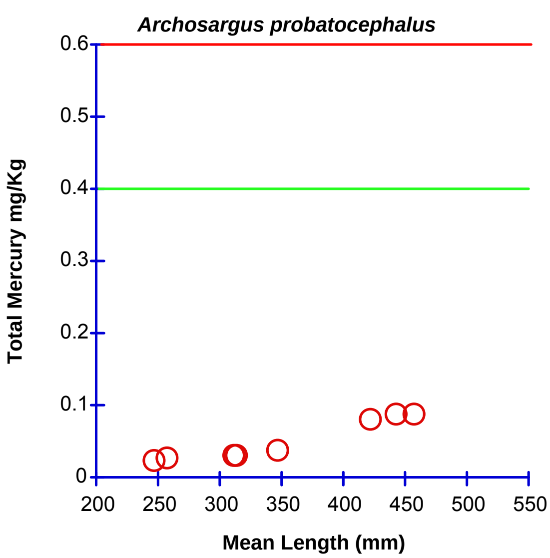
# **Sheepshead**
*Archosargus probatocephalus*

## Sample Locations



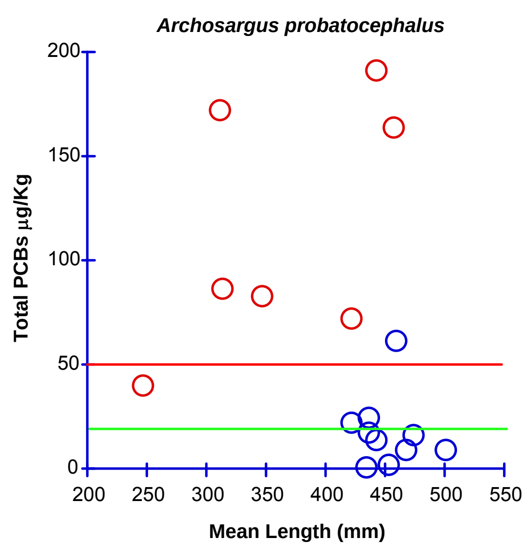

Eighteen fish were sampled from two locations: Pensacola Pass during the annual spawning aggregation, and from the Escambia Bay I-10 Bridge demolition blast. Mercury content was determined for the 8 samples taken from Pensacola pass, and although accumulation with age was observed, the concentrations were all well below the US EPA screening value. PCB content, however, was above the US EPA screening value for three of the eight samples from Pensacola Pass where fish had congregated for the annual spawning. All of the samples from the I-10 Escambia Bay Bridge were well above the US EPA Screening value. Only one sample from both locations was below the US EPA screening value for TEQ.

## Mercury Content

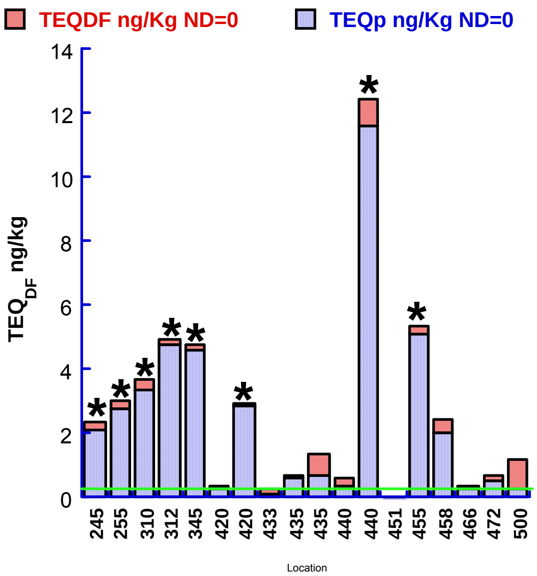



Red line: State of Florida action limit at 0.6 mg/kg. Green line: US EPA recreational consumption action limit at 0.4 mg/kg

## PCB content




State of Florida action limit 50 µg/kg (red line). US EPA recreational consumption action limit 20 µg/kg (green line). Red symbols I-10 Bridge, Esc. Bay




Toxicity of Dioxins Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in Sheepshead from Pensacola Bay. High values, with one exception, were obtained for fish collected at the I-10 bridge (starred samples) in Escambia Bay. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values.

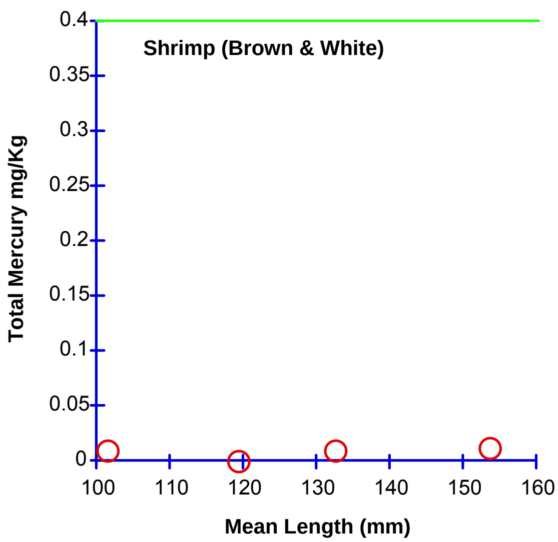
| Location | n | Mean Lgth (mm) | Mean Weight (g) | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_P$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Escambia Bay I-10 | 1 | 245 | 280.0 | 1.00 | 0.1846 | 2.1508 | 2.3354 | **41.100** | 0.025 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 255 | 340.0 | 0.80 | 0.1913 | 2.8072 | 2.9985 | **54.100** | 0.03 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 310 | 610.0 | 1.80 | **0.3154** | **3.4060** | **3.7214** | **173.00** | 0.035 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 312 | 550.0 | 0.70 | 0.2094 | 4.7738 | 4.9832 | **87.700** | 0.035 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 345 | 700.0 | 0.70 | 0.1699 | 4.6129 | 4.7828 | **83.700** | 0.039 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 420 | 1350.0 | 0.60 | 0.1026 | 2.8624 | 2.9650 | **73.600** | 0.085 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 440 | 1580.0 | 2.60 | **0.8599** | **11.599** | **12.459** | **192.00** | 0.089 | 30.519 | -87.143 |
| Escambia Bay I-10 | 1 | 455 | 1770.0 | 1.60 | **0.2838** | **5.1068** | **5.3906** | **165.00** | 0.092 | 30.519 | -87.143 |
| Pensacola Pass | 1 | 420 | 1230.0 | 0.20 | 0.0956 | 0.2458 | 0.3414 | **23.000** | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 433 | 1400.0 | 0.30 | 0.1414 | 0.1105 | 0.2519 | 2.150 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 435 | 1620.0 | 0.40 | 0.0841 | 0.6006 | 0.6847 | **25.100** | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 435 | 1310.0 | 1.00 | **0.6197** | **0.7205** | **1.3402** | 18.200 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 440 | 1670.0 | 0.90 | 0.2482 | 0.3786 | 0.6268 | 14.600 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 451 | 1650.0 | 0.30 | 0.0000 | 0.0166 | 0.0166 | 2.570 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 458 | 1550.0 | 0.60 | **0.4506** | **2.0207** | **2.4713** | **62.300** | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 466 | 1470.0 | 0.40 | 0.0857 | 0.2980 | 0.3837 | 10.200 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 472 | 1530.0 | 0.40 | 0.1522 | 0.5279 | 0.6801 | 16.700 | | 30.334 | -87.299 |
| Pensacola Pass | 1 | 500 | 1980.0 | 0.70 | **0.9019** | **0.3197** | **1.2216** | 9.640 | | 30.334 | -87.299 |

**Shrimp**
*Farfantepenaeus* spp.

## Sample Locations

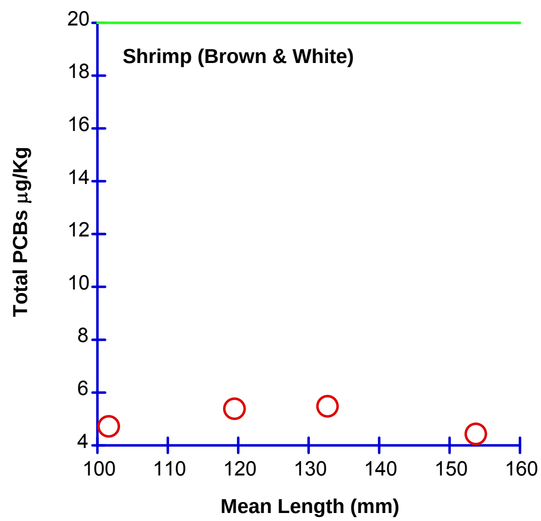
Shrimp samples (4) from Pensacola Bay were all well below screening values for mercury, PCBs and TEQ.

## Mercury Content




Red line: State of Florida action limit at 0.5 mg/kg.
Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

## PCB Content




Red line: State of Florida action limit at 50 µg/kg.
Green line: US EPA recreational consumption action limit at 20 µg/kg.

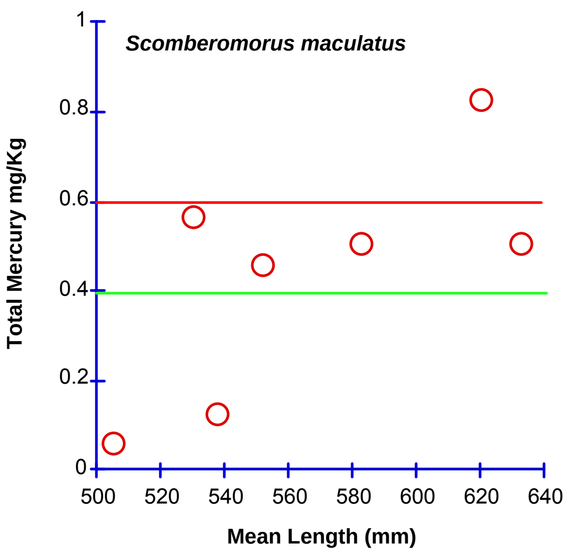
| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pens. Bay | 34 | 101 | 7.0 | 0.50 | | 0.082 | | 4.779 | 0.011 | 30.407 | -87.141 |
| Pens. Bay | 13 | 132 | 15.3 | 0.40 | 0.376 | 0.012 | 0.3877 | 5.49 | 0.011 | 30.394 | -87.185 |
| Pens. Bay | 7 | 153 | 24.4 | 0.60 | 0.263 | 0.005 | 0.2676 | 4.42 | 0.014 | 30.394 | -87.185 |
| Pens. Bay | 74 | 119 | | 0.30 | | | | 5.37 | 0 | | |

# Spanish Mackerel
*Scomberomorus maculatus*

**Sample locations:** Pensacola Pass, offshore

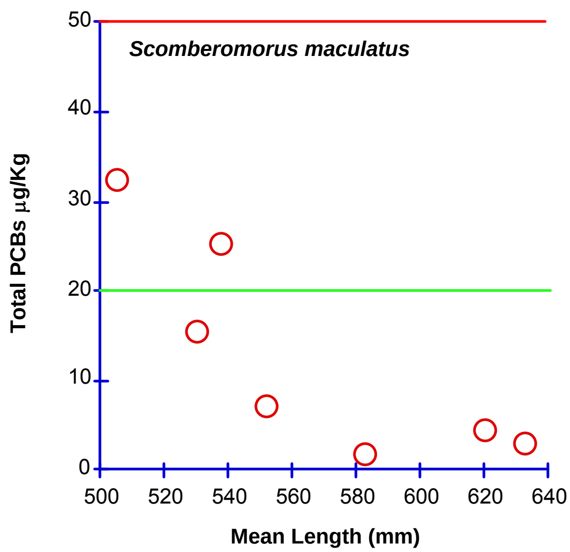
Seven samples of individual fish were collected from Pensacola pass and along the gulf shoreline of Santa Rosa Island. Mercury content increased with size of the fish, with five of seven samples exceeding the US EPA screening value. PCBs however, decreased with increasing size, with the two smallest fish exceeding the US EPA Screening value for total PCBs, consistent with younger fish foraging in the estuary and older fish moving offshore. The highest PCB toxicity as TEQ was for two of the larger specimens, indicating that despite lower total PCB, more toxic congeners were more prevalent with age.

## Mercury Content

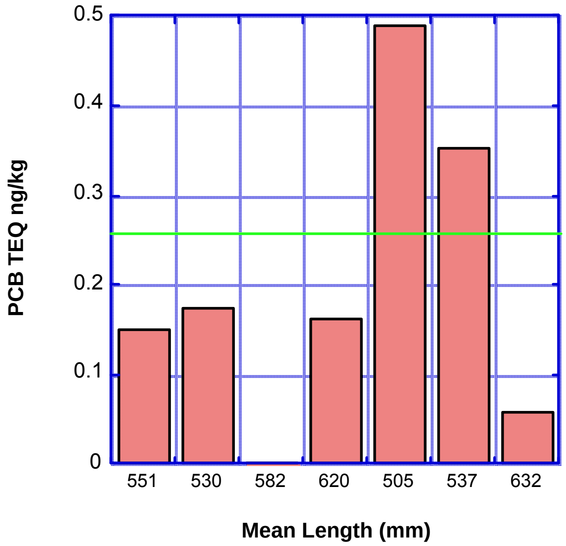



Green line: US EPA recreational consumption action limit at 0.40 mg/kg. Red line: State of Florida threshold for limited consumption at 0.60 mg/kg.

## PCB Content

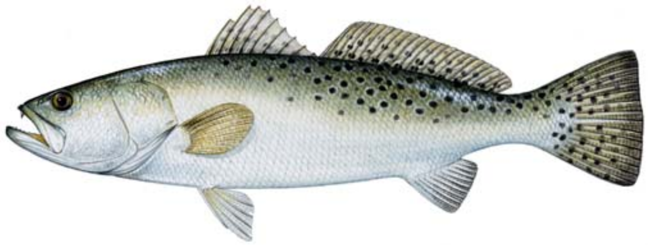



Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.



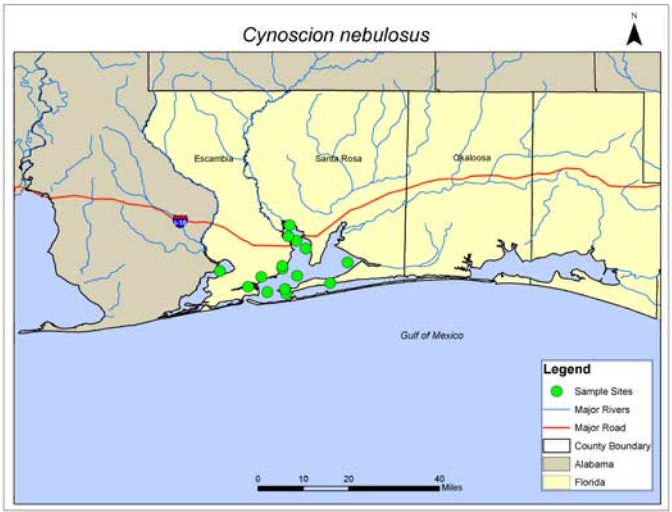

Toxicity of PCBs ($TEQ_P$) in Spanish mackerel from inshore and offshore Pensacola, FL. One sample was close to zero. The US EPA recreational consumption action limit is indicated by the green line at 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_P$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nearshore 3 Barges | 1 | 551 | 960.0 | 1.60 | 0.1026 | 0.1515 | 0.2541 | 7.350 | **0.46** | 30.288 | -87.220 |
| Offshore outer shelf | 1 | 530 | 900.0 | 1.00 | **0.2643** | 0.1733 | **0.4376** | 15.700 | **0.57** | | |
| Offshore outer shelf | 1 | 582 | 1020.0 | 0.10 | 0.0210 | 0.0008 | 0.0218 | 2.010 | **0.51** | | |
| Offshore outer shelf | 1 | 620 | 13750.0 | 0.30 | 0.0930 | 0.1619 | 0.2549 | 4.570 | **0.83** | | |
| Pensacola Bay Pass | 1 | 505 | 680.0 | 3.20 | | **0.4892** | | **32.423** | 0.062 | 30.326 | -87.307 |
| Pensacola Bay Pass | 1 | 537 | 870.0 | 2.30 | | **0.3539** | | **25.354** | 0.13 | 30.326 | -87.307 |
| Pensacola Bay Pass | 1 | 632 | 128.0 | 0.10 | 0.0012 | 0.0587 | 0.0599 | 3.020 | **0.51** | 30.326 | -87.307 |



# Spotted Seatrout
*Cynoscion nebulosus*

## Sample Locations



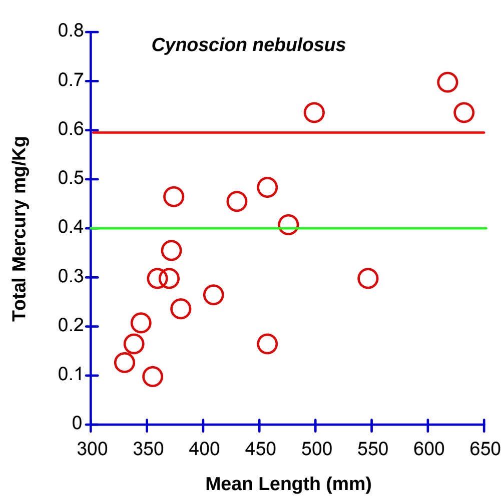

Mercury content is higher in larger fish throughout the area.

<u>Areas with High PCB samples</u>

Upper and West Escambia Bay
Bayou Grande

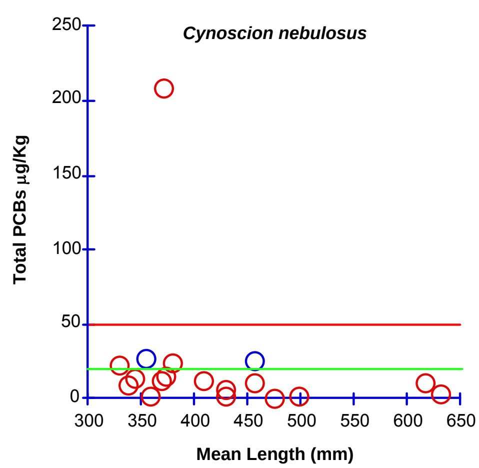
Twelve Sample locations provided 18 samples and 49 fish. Five samples were individual fish, the others were composites of 3 to 5 fish each. Mercury increased with fish size throughout the area to the point where 8 samples had mercury concentrations higher than the US EPA screening value. With the exception of a single sample, PCB content was lower than for other species sampled in the same locations, including the Escambia I-10 bridge site which had the highest PCB concentrations found during the course of the study. Five of 18 samples were above the US EPA screening value for total PCBs. Eight of 18 samples exceeded the US EPA screening value for TEQ.

## Mercury Content

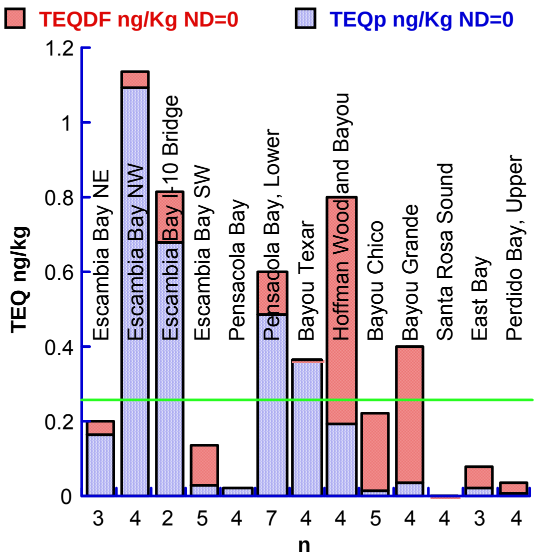



Red line: State of Florida action limit at 0.6 mg/kg.
Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

## PCB content

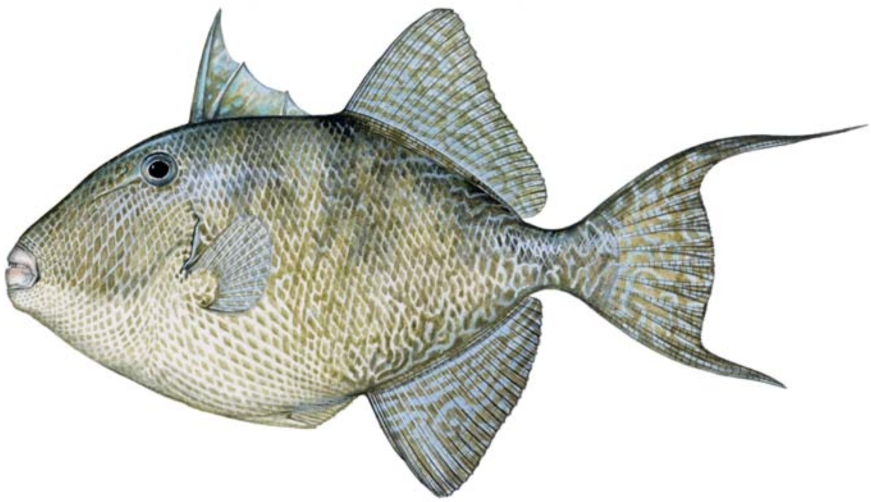



Red line: State of Florida action limit at 50 µg/kg. .
Green line: US EPA recreational consumption action limit at 20 µg/kg. Blue symbols from I-10 Bridge,




Toxicity of Dioxins Furans (TEQ$_{DF}$) and PCBs (TEQ$_{P}$) in Spotted Seatrout from NW Florida waters. Low values were recorded from East Bay, Santa Rosa Sound, and Perdido Bay. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values.

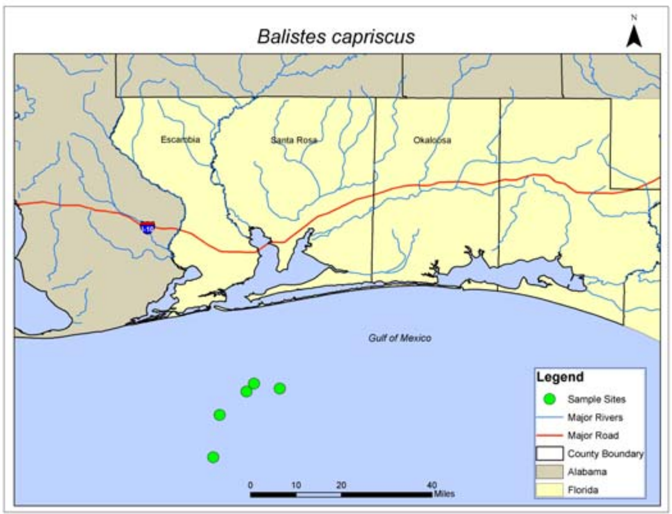
| Location | n | Mean Lgth (mm) | Mean Wgt (g) | Mean Age | % Lipid | TEQ$_{DF}$ ng/Kg ND=0 | TEQ$_{P}$ ng/Kg ND=0 | TEQ$_{DFP}$ ng/Kg ND=0 | ΣPCBs µg/Kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bayou Chico | 5 | 336 | 343.2 | 1.1 | 0.30 | 0.2014 | 0.0177 | 0.2191 | 9.276 | 0.170 | 30.404 | -87.255 |
| Bayou Grande | 4 | 328 | 284.6 | 1.1 | 0.20 | **0.3620** | 0.0367 | **0.3987** | **23.401** | 0.130 | 30.372 | -87.297 |
| Bayou Texar | 3 | 428 | 626.7 | 2.7 | 0.40 | 0.0059 | **0.6300** | **0.6359** | 6.110 | **0.460** | 30.439 | -87.188 |
| Bayou Texar | 1 | 630 | 1790.0 | 6.0 | 0.50 | 0.0000 | 0.0971 | 0.0971 | 4.030 | **0.64** | 30.439 | -87.188 |
| East Bay | 3 | 455 | 836.7 | 3.5 | 0.50 | 0.0548 | 0.0219 | 0.0767 | 10.976 | **0.490** | 30.450 | -86.980 |
| Esc. Bay I-10 | 1 | 354 | 350.0 | | 0.20 | 0.0768 | **0.6807** | **0.7575** | **27.000** | 0.1 | 30.519 | -87.142 |
| Esc. Bay I-10 | 1 | 455 | 820.0 | | 0.30 | 0.1951 | **0.6826** | **0.8777** | **26.300** | 0.17 | 30.519 | -87.142 |
| Esc. Bay NE | 3 | 407 | 623.3 | 1.8 | 0.30 | 0.0360 | 0.1638 | 0.1998 | 12.928 | 0.270 | 30.569 | -87.165 |
| Esc. Bay NW | 1 | 371 | 370.0 | 1.0 | 0.30 | 0.0185 | **2.1435** | **2.1620** | **209.32** | 0.360 | 30.533 | -87.169 |
| Esc. Bay NW | 3 | 379 | 466.1 | 1.0 | 0.40 | 0.0639 | 0.0488 | 0.1127 | **24.572** | 0.240 | 30.533 | -87.169 |
| Esc. Bay SW | 5 | 343 | 330.6 | 1.0 | 0.30 | 0.1085 | 0.0286 | 0.1371 | 14.640 | 0.210 | 30.494 | -87.113 |
| Hoffman-Woodland | 4 | 497 | 1050.0 | 2.9 | 0.70 | **0.6048** | 0.1940 | **0.7988** | 2.320 | **0.640** | 30.365 | -87.179 |
| Pensacola Bay | 4 | 368 | 420.0 | 1.7 | 0.60 | 0.0000 | 0.0234 | 0.0234 | 11.900 | 0.300 | 30.407 | -87.141 |
| Pensacola Bay, Lower | 3 | 373 | 516.7 | 3.6 | 0.10 | **0.3480** | 0.0396 | **0.3876** | 16.197 | **0.470** | 30.355 | -87.236 |
| Penscola Bay | 3 | 428 | 646.7 | 2.6 | 0.40 | 0.0000 | 0.0028 | 0.0028 | 1.630 | 0.370 | 30.355 | -87.236 |
| Penscola Bay | 1 | 615 | 1430.0 | | 0.20 | 0.0000 | **1.4071** | **1.4071** | 10.383 | **0.700** | 30.355 | -87.236 |
| Perdido Bay | 4 | 358 | 393.6 | 1.1 | 0.20 | 0.0320 | 0.0043 | 0.0363 | 1.805 | 0.300 | 30.422 | -87.387 |
| Santa Rosa Sound | 3 | 475 | 850.0 | 2.1 | 0.20 | 0.0006 | 0.0009 | 0.0015 | 0.500 | **0.410** | 30.356 | -87.100 |



## Gray Trigger

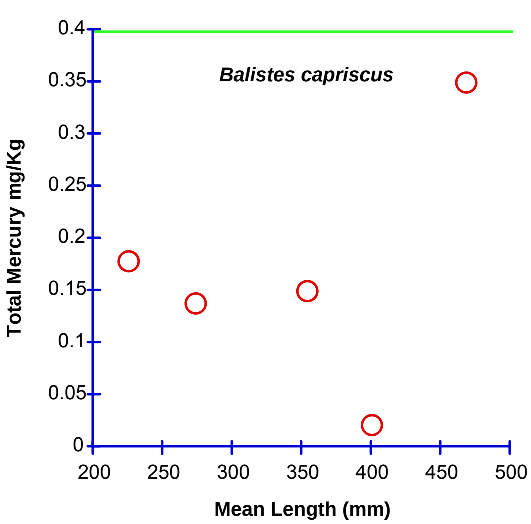
*Balistes capriscus*

### Sample locations



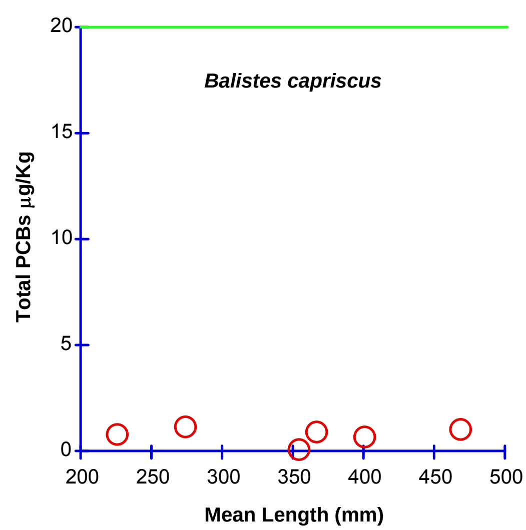

Seven samples, 6 as individual fish and one 3 fish composite were collected on offshore reefs. All fish had low mercury, PCBs, and TEQ values well below US EPA screening values.

### Mercury Content

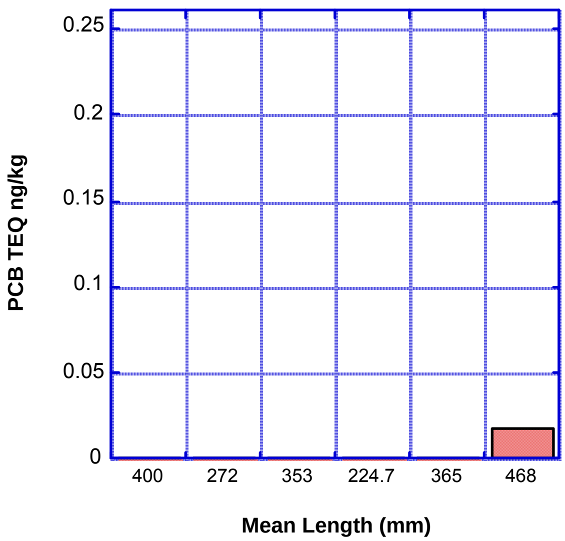



Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

### PCB Content



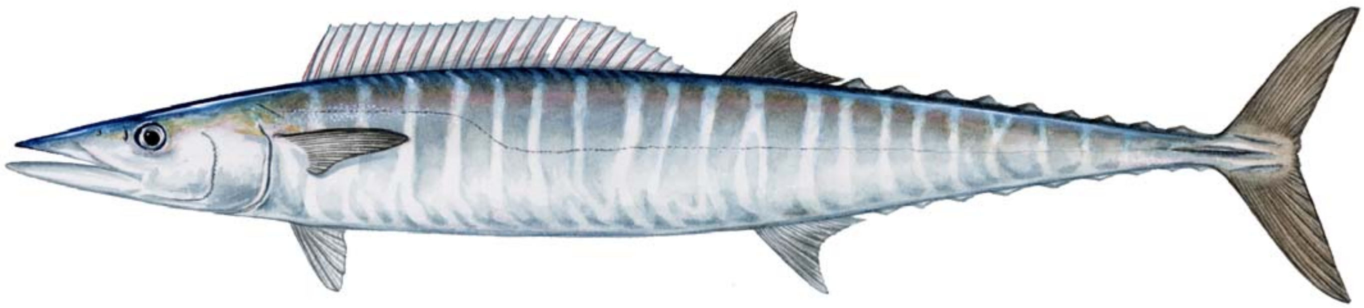

Green line: US EPA recreational consumption action limit t at 20 µg/kg.



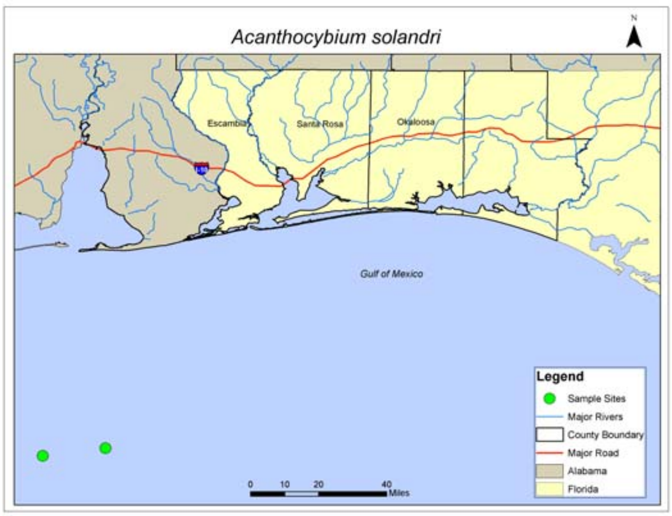

Toxicity of PCBs ($TEQ_P$) in Gray Trigger fish from offshore Pensacola, FL. Five of six samples were close to zero. The US EPA recreational consumption action limit is 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs μg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | 1 | 400 | 1560.0 | 0.02 | 0.0001 | 0.800 | 0.059 | | |
| Offshore outer shelf | | | | 0.20 | 0.0001 | 0.3233 | 0.061 | 29.983 | -87.284 |
| Offshore midshelf reef permit zone | 1 | 272 | 460.0 | 0.20 | 0.0003 | 1.270 | 0.13 | 30.058 | -87.198 |
| Offshore midshelf reef permit zone | 1 | 353 | 940.0 | 0.20 | 0.0001 | 0.2085 | 0.15 | 30.083 | -87.174 |
| Offshore outer shelf | 3 | 225 | 486.7 | 0.20 | 0.0001 | 0.831 | 0.053 | 29.983 | -87.284 |
| Offshore outer shelf | 1 | 365 | 1790.0 | 0.30 | 0.0001 | 1.020 | 0.16 | 29.847 | -87.304 |
| Offshore outer shelf | 1 | 468 | 1800.0 | 0.10 | 0.0180 | 1.148 | 0.12 | 30.067 | -87.092 |

# Wahoo, *Acanthocybium solandri*

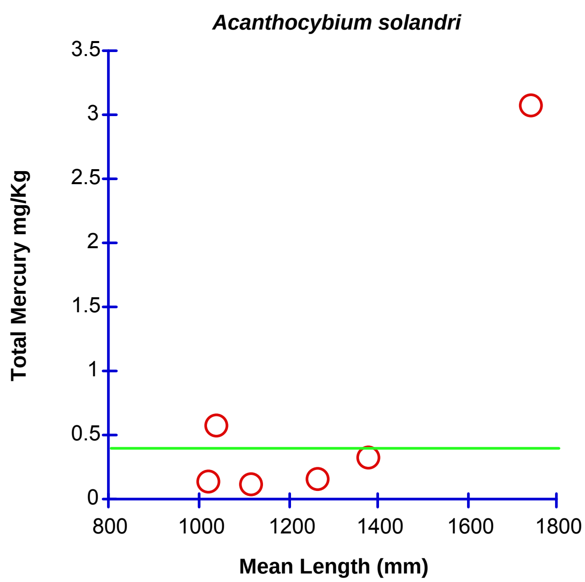


## Sample Locations



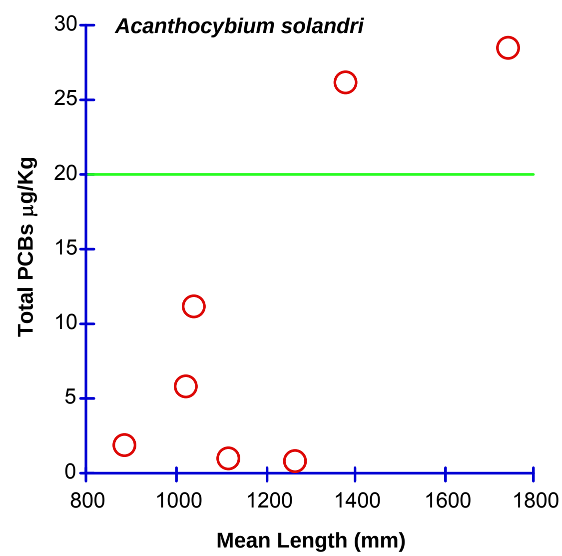

Seven specimens were sampled from offshore of Pensacola in The Gulf of Mexico. Two samples had mercury concentrations above the US EPA screening value, two samples exceeded the US EPA screening value for total PCBs, and had TEQ values based on PCB content that exceeded the screening value for TEQ.

## Mercury Content

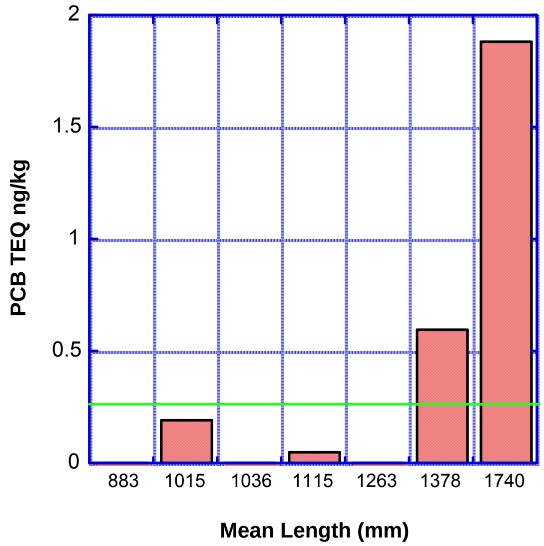



Green line: US EPA recreational consumption action limit at 0.4 mg/kg.

## PCB content

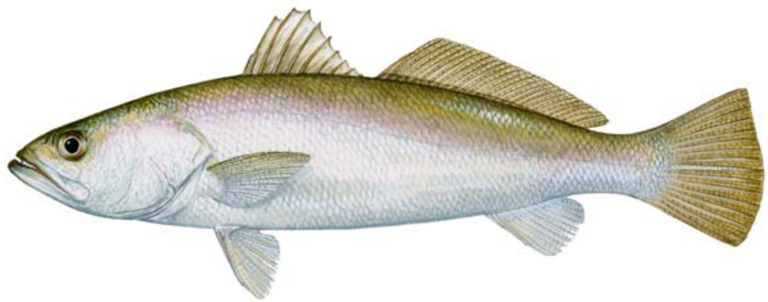



Green line: US EPA recreational consumption action limit at 20 µg/kg



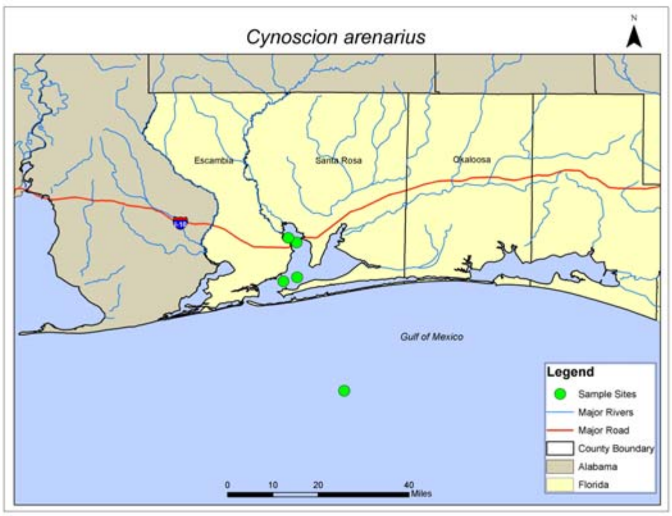

Toxicity of PCBs ($TEQ_P$) in Wahoo from offshore Pensacola, FL. Three samples were close to zero. The US EPA recreational consumption action limit is indicated by the green line at 0.256 ng/kg.

| Location | n | Mean Length (mm) | Mean Weight (g) | Sex | % Lipids | $TEQ_P$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | 1 | 883 | | M | 0.10 | 0.0006 | 1.99 | | 30.083 | -87.167 |
| Offshore outer shelf | 1 | 1015 | 6770.0 | F | 0.02 | 0.1906 | 6.020 | 0.15 | 29.383 | -87.717 |
| Offshore outer shelf | 1 | 1036 | nt | NT | 0.90 | 0.0057 | 11.400 | 0.6 | 29.317 | -88.238 |
| Offshore outer shelf | 1 | 1115 | 8520.0 | F | 0.05 | 0.0494 | 1.160 | 0.14 | 29.350 | -88.183 |
| Offshore outer shelf | 1 | 1263 | 1237.0 | F | 0.06 | 0.0001 | 0.880 | 0.18 | 29.350 | -88.183 |
| Offshore outer shelf | 1 | 1378 | nt | NT | 0.40 | **0.5983** | **26.400** | 0.35 | 29.282 | -88.204 |
| Offshore outer shelf | 1 | 1740 | nt | NT | 1.00 | **1.8916** | **28.700** | **3.1** | 29.267 | -88.188 |



# White Trout
*Cynoscion arenrius*

## Sample Locations



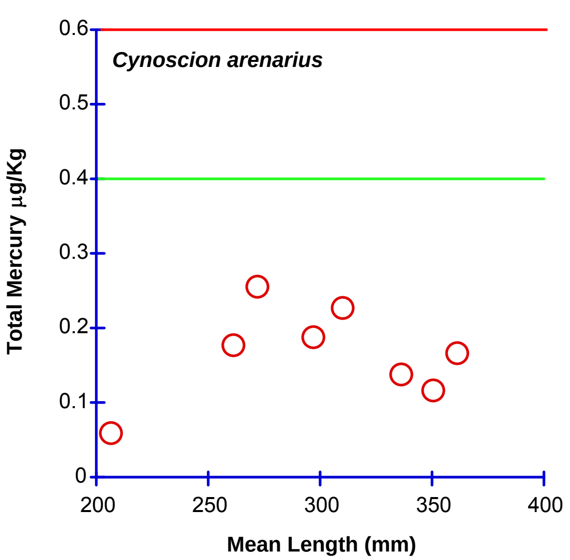

**Low mercury content in sampled fish.**

## Areas with High PCB content

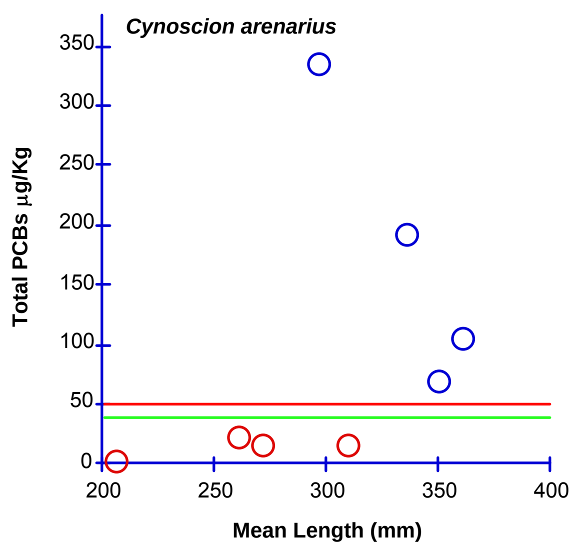
### Upper Escambia Bay/I-10 bridge

Eight samples were obtained from offshore, the Pensacola Bay three mile bridge and Escambia Bay. All samples were below US EPA screening values for mercury content, and accumulation with size was not apparent. Samples from the Escambia Bay I-10 bridge were the only ones that exceeded the screening value for total PCBs and TEQ

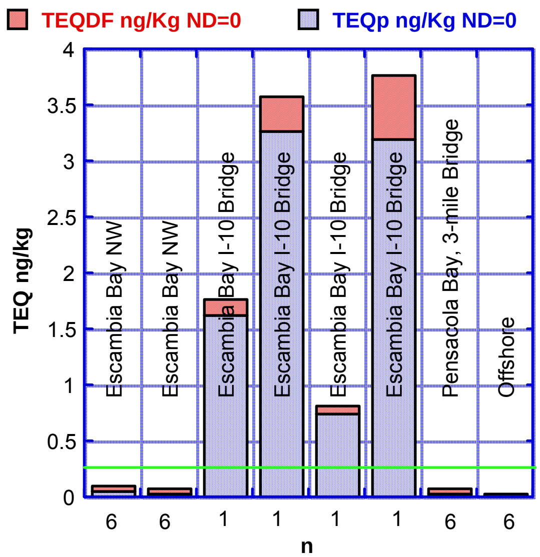
## Mercury Content




Red line: State of Florida action limit at 0.60 mg/kg. Green line: US EPA recreational consumption action limit at 0.40 mg/kg

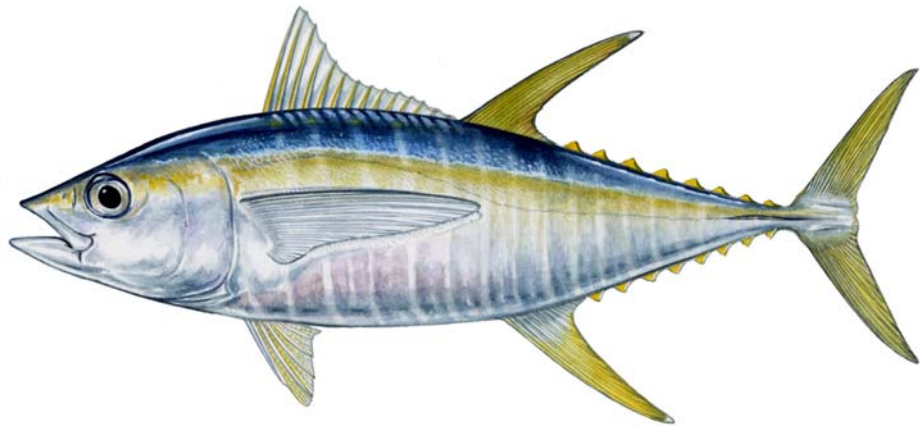



Red line: State of Florida action limit at 50 µg/kg. Green line: US EPA recreational consumption action limit at 20 µg/kg. Blue symbols from I-10 Bridge, Escambia Bay




Toxicity of Dioxins Furans ($TEQ_{DF}$) and PCBs ($TEQ_P$) in white trout from NW Florida waters. All four high values were obtained for fish collected at the Escambia Bay I-10 Bridge. The green line is the US EPA recreational consumption action limit at 0.256 ng/kg. State of Florida does not have an official action limit established for TEQ values.

| Location | n | Mean Length (mm) | Mean Weight (g) | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_P$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf | 6 | 206 | 151.2 | 1.30 | 0.0000 | 0.0369 | 0.0369 | 2.358 | 0.063 | 30.044 | -86.991 |
| Escambia Bay NW | 6 | 260 | 159.3 | 0.60 | 0.0463 | 0.0481 | 0.0944 | **22.472** | 0.180 | 30.533 | -87.169 |
| Escambia Bay NW | 6 | 271 | 177.3 | 0.50 | 0.0399 | 0.0295 | 0.0694 | 15.820 | 0.260 | 30.533 | -87.169 |
| Escambia Bay I-10 Bridge | 4 | 296 | 237.5 | 0.30 | 0.1590 | **1.6121** | **1.7711** | **336.00** | 0.19 | 30.519 | -87.143 |
| Pensacola Bay, 3-mile Bridge | 6 | 309 | 284.9 | 1.00 | 0.0463 | 0.0263 | 0.0726 | 15.727 | 0.230 | 30.394 | -87.185 |
| Escambia Bay I-10 Bridge | 1 | 335 | 330.0 | 0.60 | **0.3196** | **3.2589** | **3.5785** | **192.00** | 0.14 | 30.519 | -87.143 |
| Escambia Bay I-10 Bridge | 1 | 350 | 440.0 | 0.30 | 0.0570 | **0.7504** | **0.8074** | **70.900** | 0.12 | 30.519 | -87.143 |
| Escambia Bay I-10 Bridge | 1 | 360 | 460.0 | 0.60 | **0.5696** | **3.2012** | **3.7708** | **105.00** | 0.17 | 30.519 | -87.143 |

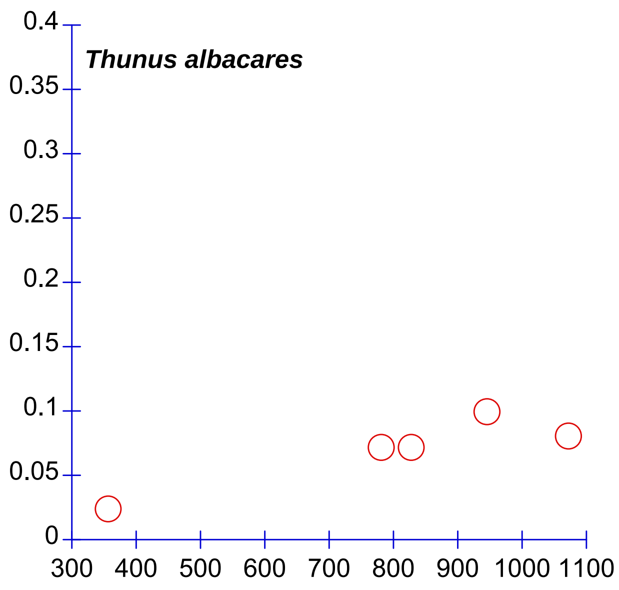


**Yellowfin Tuna**
*Thunnus albacares*

**Sample locations:** offshore

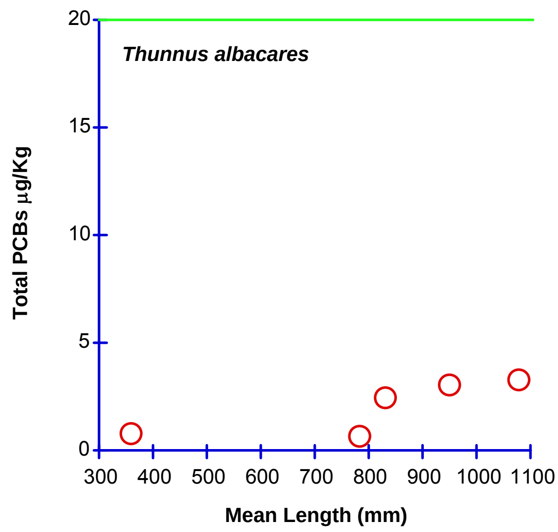
Six samples from individual fish were obtained from Offshore, and all were below screening values for mercury, total PCBs and TEQ

## Mercury Content

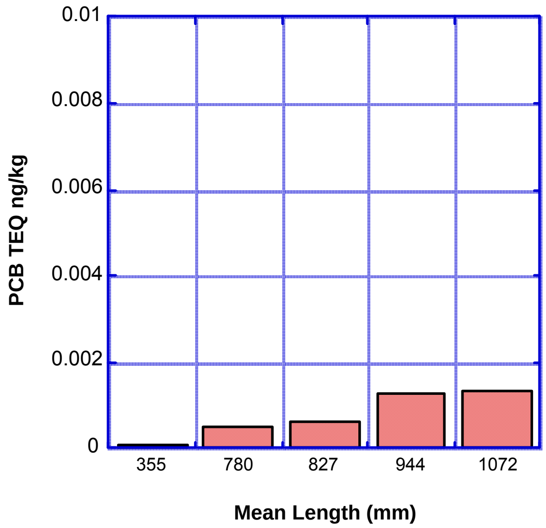



Green line: US EPA recreational consumption action limit at 0.40 mg/kg

## PCB Content




Green line: US EPA recreational consumption action limit at 20 µg/kg. These fish were taken offshore.




Toxicity of PCBs ($TEQ_P$) in yellow fin tuna from offshore Pensacola, FL. All samples were close to zero. The US EPA recreational consumption action limit is 0.256 ng/kg.

| Location | n | Mean Length (mm) | % Lipids | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_P$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|
| Offshore Ram Powell | 1 | 355 | 0.30 | | 0.0001 | | 0.907 | 0.025 | 29.060 | -88.091 |
| Offshore Ram Powell | 1 | 780 | 0.20 | 0.0000 | 0.0005 | 0.0005 | 0.714 | 0.072 | 29.060 | -88.091 |
| Offshore Ram Powell | 1 | 827 | 0.20 | 0.0161 | 0.0006 | 0.0167 | 2.520 | 0.072 | 29.060 | -88.091 |
| Offshore Ram Powell | 1 | 944 | 0.20 | 0.0061 | 0.0013 | 0.0074 | 3.130 | 0.1 | 29.060 | -88.091 |
| Offshore Ram Powell | 1 | 1072 | 0.10 | 0.0005 | 0.0014 | 0.0019 | 3.440 | 0.081 | 29.060 | -88.091 |
| Offshore Ram Powell | 1 | | 0.20 | 0.0449 | 0.0028 | 0.0477 | 6.720 | | 29.060 | -88.091 |

## Miscellaneous Species

| Location | Species | n | Mean L (mm) | Mean Wgt (g) | Sex | % Lipid | $TEQ_{DF}$ ng/kg ND=0 | $TEQ_{P}$ ng/kg ND=0 | $TEQ_{DFP}$ ng/kg ND=0 | ΣPCBs µg/kg | Hg mg/kg | LAT | LONG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Offshore outer shelf<br>Teneco Reef | *Calamus leucosteus* | 2 | 385 | 970.0 | | 0.20 | | 0.0526 | | 2.183 | 0.25 | 29.998 | -87.086 |
| Offshore outer shelf | *Caranx crysos* | 1 | 307 | 700.0 | | 0.24 | | 0.1323 | | 7.9053 | 0.32 | 30.043 | -87.007 |
| Offshore outer shelf | *Centropristis ocyura* | 13 | 102 | 35.7 | | 0.30 | | 0.0402 | | 2.25 | 0.052 | 29.984 | -87.084 |
| Offshore outer shelf | *Centropristis ocyura* | 18 | 108 | 42.6 | | 0.00 | | 0.0002 | | 1.136 | 0.054 | 30.044 | -86.991 |
| ex-Oriskany | *Etrumeus teres* | 18 | 139 | 22.0 | | 2.00 | 0.1808 | **0.3643** | **0.5451** | 4.35 | 0.023 | 30.043 | -87.007 |
| ex-Oriskany | *Etrumeus teres* | 102 | 145 | | | 2.20 | | 0.2221 | | 8.61 | 0.017 | 30.043 | -87.007 |
| Offshore midshelf | *Haemulon aurolineatum* | 11 | 210 | 139.5 | | 0.20 | | 0.0005 | | 1.804 | 0.073 | 30.189 | -87.218 |
| Offshore midshelf reef permit zone | *Haemulon aurolineatum* | 10 | 198 | 124.0 | | 0.00 | | 0.0008 | | 2.028 | 0.047 | 30.082 | -87.195 |
| Escambia River | *Ictalurus punctatus* | 1 | 510 | 1140.0 | F | 1.80 | **0.5705** | **0.7067** | **1.2772** | **114.88** | | 30.646 | -87.262 |
| Escambia River Upper | *Ictalurus punctatus* | 1 | | 880.0 | F | 3.50 | **1.0479** | **0.7067** | **0.6757** | **17.984** | | 30.646 | -87.262 |
| Offshore outer shelf | *Lagodon rhomboides* | 15 | 140 | 75.1 | | 0.60 | | 0.0294 | | 2.819 | 0.086 | 30.044 | -86.991 |
| Offshore outer shelf | *Leiostomus xanthurus* | 15 | 153 | 91.4 | | 0.60 | 0.0000 | 0.0192 | 0.0192 | 1.825 | 0.074 | 30.044 | -86.991 |
| Pensacola Bay, Lower | *Leiostomus xanthurus* | 5 | 259 | 217.8 | | 2.00 | 0.2480 | 0.0382 | **0.2862** | **21.215** | 0.071 | 30.355 | -87.236 |
| Inshore | *Loligo* sp. | 2 | 157 | 99.3 | | 1.20 | | 0.1012 | | 4.21 | 0.056 | 30.188 | -87.278 |
| Offshore outer shelf | *Loligo* sp. | 4 | 120 | 58.9 | | 0.30 | | 0.0010 | | 2.42 | 0.039 | 29.984 | -87.084 |
| Offshore outer shelf | *Lutjanus griseus* | 1 | 252 | 420.0 | | 0.60 | 0.0000 | 0.0016 | 0.0016 | 1.701 | 0.083 | 30.052 | -87.306 |
| Offshore outer shelf | *Lutjanus griseus* | 1 | 270 | 510.0 | M | 0.50 | 0.0000 | 0.0755 | | 2.228 | 0.13 | 29.983 | -87.284 |
| Offshore midshelf reef permit zone | *Pagrus pagrus* | 1 | 317 | 435.0 | | 0.40 | | 0.1197 | | 2.98 | 0.31 | 30.083 | -87.174 |
| Offshore outer shelf | *Pagrus pagrus* | 3 | 205 | 248.8 | | 0.10 | | 0.0002 | | 1.38 | 0.078 | 29.961 | -87.110 |
| Offshore outer shelf | *Pagrus pagrus* | 5 | 319 | 384.7 | | 0.50 | | 0.0338 | | 2 | 0.15 | 30.078 | -87.087 |
| Offshore outer shelf | *Prionotus scitulus* | 6 | 189 | 153.6 | | | | 0.0002 | | 0.567 | | 29.984 | -87.084 |
| Offshore outer shelf | *Prionotus scitulus* | 6 | 231 | 153.6 | | | | | | 0.6026 | | 29.984 | -87.084 |
| Offshore outer shelf | *Rachycentron canadum* | 1 | 875 | | | 0.25 | | 0.1236 | | 13.300 | 0.021 | | |
| Inshore | Sand Dollars | 20 | 30 | 1.1 | | 0.30 | | 0.0008 | | 2.36 | 0.004 | 30.192 | -87.278 |
| Offshore outer shelf | Serranus phobe | 9 | 123 | 54.2 | | | | | | 1.090 | | 30.048 | -86.993 |
| Offshore outer shelf | *Sphaena barracuda* | 1 | 847 | 5030 | F | 0.11 | | 0.1391 | | 8.230 | 0.48 | 29.383 | -87.917 |
| Offshore outer shelf | *Syacium papillosum* | 1 | 215 | 170.0 | | 0.01 | | 0.0624 | | 4.550 | 0.023 | 30.043 | -87.007 |
| Offshore outer shelf | *Synodus foetens* | 6 | 208 | 92.2 | | 0.50 | | | | 1.89 | 0.029 | 30.044 | -86.991 |
| Offshore outer shelf | *Synodus foetens* | 1 | 374 | 640.0 | | 0.80 | | 0.0004 | | 1.86 | 0.37 | 29.961 | -87.110 |
| Offshore outer shelf | *Trachinocephalus myops* | 1 | 195 | 137.0 | | 0.20 | | 0.0192 | | 1.9 | | 30.048 | -86.993 |
| Offshore outer shelf | *Trachurus lathami* | 41 | 98 | 10.9 | | 0.10 | | 0.0590 | | 2.164 | 0.01 | 29.961 | -87.110 |