

IMPACTS OF MERCURY CONTAMINATION IN THE SOUTHEASTERN UNITED STATES

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Abstract. Mercury (Hg) contamination from a variety of point and non-point sources, including atmospheric inputs, is currently considered to be the most serious environmental threat to the well being of fish and wildlife resources in the southeastern United States. Fish consumption advisories have been issued in all ten states comprising the U.S. Fish and Wildlife Service's Southeast Region. Both freshwater and marine species have been affected with levels ranging as high as 7.0 ppm in some individuals. Many other species, including various species of reptiles, birds and mammals (including humans) are also contaminated. Impacts noted range from reproductive impairment to mortality.

1. Introduction

Although early investigations (Ogden *et al*, 1973; USFWS, unpubl. data) found elevated levels of mercury (Hg) in some piscine and avian species in Florida, intensive study of Hg contamination did not begin in the southeastern U.S. until 1989 when an endangered female Florida panther (*Felis concolor coryi*) was found dead in Everglades National Park. Tissue analyses revealed that the only contaminant present in relatively high levels was Hg (110 mg/kg [ppm] fresh weight in liver tissue). Consequently, Hg toxicosis was assigned as the cause of death (Roelke, 1990). This single event was the impetus for further studies investigating the sources and impacts of Hg contamination in the U.S. Fish and Wildlife Service's Southeast Region (Region) since 1989. The purpose of this paper is to present a brief synthesis of many of these.

2. Results and Discussion

The Region, comprised of ten southeastern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee), the Commonwealth of Puerto Rico and the U.S. Virgin Islands, also contains more than 100 National Wildlife Refuges (NWR). Fish consumption advisories, issued when mean Hg concentrations exceed the Food and Drug Administration (FDA) limit of 1.0 ppm (0.5 ppm in Florida), have been issued in all ten states.

Mercury sources within the Region are many and varied. A chlor-alkali facility was a major contributor in Alabama where sediment concentrations in excess of 7,500 ppm have been found (EAES&T, 1992). Concentrations in chain pickerel (*Esox niger*) from the area ranged from 0.52 to 3.5 ppm, and both frogs (*Rana* sp.) and snakes (*Agkistrodon piscivorus*) contained levels up to 1.6 ppm. Current studies are addressing the impact of Hg contamination on the health and reproduction of a neotropical migrant, the prothonotary warbler (*Prothonotaria citrea*). Mercury has been detected in nestlings and eggs, but histological examination and hormone assays are not yet complete.

Mercury-charged manometers used to measure pressure and delivery from natural gas wells are a major source of contamination in northeast Louisiana. Soil concentrations up to 141,000 ppm have been measured (Louisiana Department of Environmental Quality, unpubl. data) on Upper Ouachita NWR. Mercury levels in largemouth bass (*Micropterus salmoides*) collected in 1992 ranged from 0.52 to 4.04 ppm. Bass from 12 lakes, some of which are within the area of the gas field, were collected in 1993. Concentrations ranged from below detection limits (0.001 ppm) to 1.53 ppm. Other species also have been contaminated. Concentrations in liver tissue of great blue herons (*Ardea herodias*) and raccoons (*Procyon lotor*) from Upper Ouachita NWR ranged from 2.8 to 109.6 ppm and from 2.2 to 26.5 ppm, respectively. In addition, there has been one confirmed case of Hg toxicosis in a human male living near Monroe, Louisiana (Cormier, 1994).

In Tennessee, maximum Hg concentrations result from previous operations of the nuclear facility at Oak Ridge. Sediments in wetland areas adjacent to East Fork Poplar Creek contain more than 1,100 ppm Hg. Concentrations as high as 6.0, 33.2, 3.5 and 7.9 ppm were found in crayfish, earthworms, wrens and shrews, respectively. Stonerollers (*Campostoma anomalum*), a minnow common to the midwestern U.S., contained as much as 6.4 ppm Hg and concentrations in redbreast sunfish (*Lepomis auritus*) ranged from 0.2 to 1.9 ppm. A "no consumption" advisory has been issued.

Pharmaceutical company effluents have enriched sediments in localized areas of Puerto Rico to concentrations of 88 ppm. Mean Hg levels in tilapia (*Tilapia* sp.; =0.16 ppm) and tarpon (*Megalops atlantica*; =0.11 ppm) were well below FDA limits. However, levels of this magnitude could pose a threat to sensitive species of fish-eating birds (Eisler, 1987) and could have been a contributing factor in a major pelican die-off which occurred prior to plant shut-down.

Except for the lower reaches of the Ouachita and Saline Rivers in southeastern Arkansas, atmospheric deposition may be the major source of contamination in the other areas of the region. At Felsenthal NWR (Arkansas), in the Ouachita River basin immediately north of the Louisiana state line, concentrations are much higher than one would expect from atmospheric deposition alone. Abandoned cinnabar mines northwest of the refuge were suspected as the major source; however, it has been shown that Hg levels in fish living in these abandoned mine pits are below FDA limits. Mercury concentrations >3.0 ppm (geometric mean=0.65 ppm) have been found in fillets of bass and other top predators inhabiting the contaminated area (Giese, 1994). Muscle and liver tissue from a river otter (*Lutra canadensis*) collected adjacent to the refuge contained 5.3 and 19.1 ppm Hg, respectively. The Department of Health analyzed sera from 236 persons who admitted consuming more than 2 meals of fish per month from restricted

waters. Of these, 36 individuals had concentrations >20 ppb. However, no clinical signs of toxicosis were observed (Giese, 1994).

In North Carolina, the major area of known Hg contamination is the Lumber River basin. Of 32 stations sampled by the Department of Environmental Health and Natural Resources, fish at 19 stations contained Hg levels exceeding the FDA limit (Hale, 1994). Mean concentrations in muscle and liver tissues from raccoons ($n=6$) collected on the Alligator River NWR in the northeastern corner of the state were 0.28 (range=0.18-0.61) and 1.77 (range=1.03-3.40) ppm, respectively. In addition, blood and hair of 78 persons living near Lake Waccamaw were analyzed in 1993. The three highest levels noted were 141, 78 and 29 $\mu\text{g/L}$ (ppb). None of those persons tested exhibited any clinical signs of Hg toxicosis.

The South Carolina Department of Health and Environmental Control issued consumption advisories for 13 Lowcountry rivers and the Intercoastal Waterway in March 1994. This action resulted from an extensive sampling program conducted during the previous year. Mercury concentrations in largemouth bass and bowfin (*Amia calva*) were generally greater than those in other species, ranging from <0.25 ppm (both bass and bowfin) in the Santee River to 7.0 ppm in a bowfin from the Little Pee Dee River.

Mercury contamination in Georgia has only been reported in the Okefenokee Swamp and two of the rivers draining it; the Suwannee and the St. Marys. Consumption advisories have been issued for both rivers, but, as yet, mean levels in fish from the swamp are still below the FDA limit. Raccoons ($n=5$) from Okefenokee had levels of Hg greater than those from North Carolina. Mean concentrations were 0.47 (range=0.23-0.80) and 2.26 (range=1.08-3.81) ppm in muscle and liver, respectively.

Although 75% of largemouth bass sampled in Mississippi contained Hg concentrations >0.5 ppm, only a few exceeded the FDA limit (Folmar, 1994). Consequently, there are currently no state-issued consumption advisories in effect in Mississippi. However, only limited consumption of bass from Tallahatchie and Dahomey NWRs is recommended by the Service.

A fish consumption advisory was issued by Kentucky in November 1993 for the Western Kentucky Wildlife Management Area (WMA) where Hg levels in largemouth bass were as high as 1.29 ppm. The WMA was formerly a U.S. Department of Defense ordnance facility; the probable source of contamination.

Florida presents a special case. Due to the presence of the Florida panther, and the research conducted to determine impacts of Hg contamination on this endangered species, much more is known regarding the source and impacts of Hg in this state than perhaps any other in the Region. Although atmospheric deposition appears to be the major source of Hg, much of this deposition may be from local sources. A recent study (KBN, 1992) indicated that as much as 61% of total Hg emissions in the state were from anthropogenic sources; and that almost one-third of these emissions were derived from incineration of municipal solid wastes and medical wastes. These emissions appear to have a direct impact on nearby areas (Delfino *et al.*, 1993).

Roelke *et al.* (1991) found that reproductive success of the Florida panther, measured in terms of the number of offspring surviving to age 6 months, was significantly correlated with Hg levels in the blood of lactating females. They also found that the major source of Hg for panthers was the raccoon. Maximum mean Hg levels in raccoon muscle

and liver tissues sampled during 1984-1991 (1.80 and 24.0 ppm, respectively) were from animals ($n=5$) collected in Shark Slough, Everglades National Park, adjacent to the territory of the female which died of Hg toxicosis (Roelke *et al.*, 1991). Analyses conducted since 1991 have shown even greater levels of Hg (7.17 and 39.3 ppm in muscle and liver, respectively) in raccoons from south Florida. These levels are greater than any found in the literature. The mean concentration in alligator (*Alligator mississippiensis*) muscle from Shark Slough animals ($n=5$) was slightly less at 3.57 ppm.

Extensive fish sampling throughout the state has shown that the greatest contaminant loads (>3.0 ppm) are in the Everglades area. Most of this area is covered by a no consumption advisory. Marine species also are contaminated. Spotted seatrout (*Cynoscion nebulosus*) from various coastal NWRs have Hg levels in excess of 1.4 ppm. Behavioral and reproductive impacts of Hg on wading birds are currently under study.

3. Conclusions

Mercury contamination in the Southeastern U.S. is a major problem. It is likely that many areas yet to be investigated are also contaminated. Additionally, the potential for unreported human health problems should be investigated. Although a satisfactory solution to problems stemming from area sources may be elusive, it is imperative that point sources be identified and regulated.

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