4103 - FINAL

MERCURY AND LEAD LEVELS IN FISH OF THE OKEFENOKEE NATIONAL WILDLIFE REFUGE

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Introduction

Okefenokee Swamp is a blackwater peat wetland covering 438,000 acres in southeastern Georgia and northeastern Florida. The majority of this important ecological system (395,080 acres) is protected within the boundaries of Okefenokee National Wildlife Refuge (NWR). The Refuge is comprised of 353,981 acres of Class I Wilderness Area and the International Wetlands Convention has designated the Okefenokee Swamp as a "Wetland of International Importance." The Okefenokee NWR Hosts approximately 400,000 visitors per year. This study was initiated to evaluate mercury levels in fish from Okefenokee National Wildlife Refuge to determine the potential human health risks.

This vast shallow peat bog is the headwaters of both the Suwannee River leading to the Gulf of Mexico and the St. Mary's River leading to the Atlantic Ocean. Approximately 90 percent of the Okefenokee National Wildlife Refuge is open marshland prairies with cypress-blackgum forests, scrublands and small marshland ponds and lakes. About 20 percent of the Okenefenokee's water budget comes from runoff from upland areas. Most of this inflow occurs in the northwestern periphery from a drainage basin of about 250,000 acres. This inflow increases the potential contaminant burden in the refuge. Recent ditching by timber companies adjacent to the refugee and their subsequent use of herbicides for vegetative management of ditches draining into the swamp provides additional pathways for contaminants entering the refuge. In Addition to naturally occurring mercury in large peat deposits, pesticides have historically contained considerable amounts mercury.

Mercury contamination from many sources, including atmospheric deposition is a serious threat to fish and wildlife resources in the Southeastern United States (Facemire et al., in press). Studies conducted by Georgia Department of Natural Resources and the University of Georgia report high levels of mercury in largemouth bass (Micropterus salmoides) and fliers (Centrarchus macropterus) from the two rivers originating in Okefenokee Swamp, the St. Marys and Suwannee. These mercury levels exceeded the FDA recommended range of one part per million (ppm) in fish fillets. Florida officials issued a health advisory in 1989 based on mercury levels in fish from these rivers. Due to the acidic nature of the Okefenokee swamp (Average pH 4.5) and naturally occurring mercury leaching from peat beds, the possibility exists that high concentrations of this contaminant have been mobilized. Elemental mercury is readily methylated in the presence of low pH conditions, and methylated mercury is more bioavailable than the elemental form. Currently there is no fish consumption advisory for the Okefenokee Swamp.

Methods

Fish were collected from the east and west sides of Okefenokee NWR by electroshocking and gill nets during March of 1990 and May of 1991 by personnel from the U.S. Fish and Wildlife Service, Charleston Field Office, Panama City Field

Office and Okefenokee NWR. Suwannee Canal Recreational Area (SCRA), Monkey Lake and Double Lakes made up the East region while the West region consisted of the Sill area and Billys Lake. Temperature, pH, dissolved oxygen, conductivity and depth were measured. Individual fish were collected and identified as to species and weights and total lengths were recorded. Fish were dissected and the fillets removed, wrapped in aluminum foil and frozen awaiting chemical analyses. A South Carolina Wildlife and Marine Resources Department fisheries biologist aged the fish using otoliths and fish were placed in year categories (i.e. 1, 2, 3 or 4). Analyses for lead and mercury were performed by the Research Triangle Institute, Raleigh, N.C. The protocol for the analyses are listed below.

Homogenization. Tissue samples were prehomogenized using a food processor. A portion of the tissue sample was then freeze dried for determination of moisture content and ground to 100 mesh with a mill.

Digestion for Graphite Furnace and Cold Vapor Atomic Absorption (GFAA) Measurement. Using a CEM microwave oven, 0.25 to 0.5 g of freeze dried sample is heated in a capped 120 ml Teflon vessel in the presence of 5 ml of Baker Instra-Analyzed nitric acid for three minutes at 120 watts, three minutes at 300 watts, and fifteen minutes at 450 watts. The residue is diluted to 50 ml with laboratory pure water.

Cold Vapor Atomic Absorption (CVAA). Hg measurements are conducted using SnC14 as the reducing agent and a Leeman PS200 Hg Analyzer.

Results

Thirty five fish were collected for analyses; 27 from the east side and 8 from the west side. Samples contained representatives of four species; chain pickerel (Exos niger), flier (C. macropterus), largemouth bass (M. salmoides) and warmouth (Lepomis gulosus). The mean age and weights of these species are shown in Table 1.

The arithmetic mean mercury concentration for the 35 fish fillets was 0.359 $\pm$ 0.21 mg/L (wet weight) and 1.69 $\pm$ 0.92 mg/L (dry weight). There were no significant differences within species, among species or between years. For wet weights, the range of mercury within the fillets was from 0.136 ppm (flier) to 1.003 ppm (largemouth bass). Typically, the mean wet weight mercury residue values reflect the trophic relationship of each species of fish. Mean wet weight mercury concentrations for each species are as follows: five flier fillets 0.198 ppm, nine warmouth fillets 0.237 ppm, 13 chain pickerel fillets 0.345 ppm, eight largemouth bass fillets 0.629 ppm. (Table 2). The dry weight mercury concentrations of the fillets ranged from 0.56 ppm (chain pickerel) to 4.22 ppm (largemouth bass) (Table 3).

The mean wet weight lead concentrations for the 35 fish fillets was 0.505 $\pm$ 0.51 mg/L. The mean dry weight lead concentrations for the 35 fish fillets was 2.68 $\pm$ 2.21 mg/L. There were no significant differences within species, among species or between

years. Twenty five of the thirty five fillet samples showed detectable lead levels that ranged from 0.213 ppm to 1.56 ppm. Statistically meaningful results were not obtainable due to the large variances and small sample sizes.

Discussion

While the limited sample size of fish collected for this study inhibit statistically sound conclusions, the range of the preliminary results warrants further investigation of mercury and lead concentrations in the biota of the Okefenokee Swamp. Normal background levels of mercury in wild fish are expected to average between 0.20 and 0.26 ppm (Fimreite, 1979). Additionally, samples from progressively larger fish within the same sample location should consistently yield higher mercury concentrations, however, the limited sample size precluded this determination. Three of the samples analyzed showed mercury levels that exceed the EPA's recommended criteria of 0.57 ppm for protection of aquatic life (EPA 1980). One sample of largemouth bass fillets exceeded the FDA's consumption recommendation of one part per million (wet weight), and concentrations in several other samples approached these values. While muscle tissue accounts for around 90% of the total mercury load in fish (Eisler, 1987), any additional sampling should include whole body analysis of the fish to quantify the total mercury load. This is especially important when considering the threats to wildlife, including fish eating birds. Research involving avian species has shown reproductive incompetence and behavioral problems when subjects regularly ingested methylmercury at concentrations of 0.50 ppm (Heinz, 1979). Mercury is known to accumulate in myelinated tissues and has been shown to interfere with mitotic activity through disruption of spindle fiber formation (Lee and Dixon, 1975).

There is no FDA criteria for lead in fish, however, a limit often used for food in general is 0.3 ppm (Eisler, 1987). As with mercury, lead is more soluble and bioavailable to aquatic biota under low pH conditions (Eisler 1987), and lead values from fillet samples were also unusually high for an ecosystem as relatively isolated as Okefenokee Swamp.

Mercury and lead values identified for the small number of samples collected present ample reason to further explore the contaminants issue and determine whether there is a human health risk from the consumption of fish from Okefenokee Swamp.

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