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Marine Pollution Bulletin 50 (2005) 291–300
MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbul

Mercury concentrations in red drum, *Sciaenops ocellatus*, from estuarine and offshore waters of Florida

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Abstract

Dorsal muscle tissue from 712 red drum, *Sciaenops ocellatus*, from Florida waters were analyzed for total mercury content. Mercury levels detected in these red drum varied but in most study areas were usually lower than regulatory threshold guidelines. Total mercury levels in individual fish from all study areas ranged from 0.020 to 3.6 ppm (wet weight). Total mercury levels detected in red drum from the Florida Keys-Florida Bay area were often higher than those in fish from all other estuarine study areas. Positive relationships between total mercury levels and fish size (length and weight) and fish age were observed in most Florida study areas, indicating that mercury levels tend to increase over time as red drum grow. The majority of large, mature red drum examined contained mercury levels greater than the 0.5-ppm threshold level set by the Florida Department of Health (DOH). Approximately 94% of all adult red drum from offshore waters adjacent to Tampa Bay contained mercury levels greater than or equal to the 0.5-ppm threshold level, and 64% contained levels greater than or equal to the DOH 1.5-ppm "no consumption" level. All fish from this area with mercury levels greater than 1.5 ppm were large individuals ($\geqslant$670 mm SL). Eight percent of legal-size red drum from Florida waters contained total mercury levels greater than or equal to the 0.5-ppm threshold level. The majority (52%) of these legal-size fish greater than or equal to 0.5 ppm were from the Florida Keys-Florida Bay area. In the Florida recreational fishery, the current maximum size limit for this species is an effective filter that prevents humans from consuming those red drum with the greatest likelihood of containing high mercury levels.

Keywords: Contaminants; Heavy metals; Mercury; Sciaenidae; Recreational fishery; Red drum; Redfish

1. Introduction

The red drum, *Sciaenops ocellatus*, inhabits estuarine and offshore waters of the US Atlantic coast from Massachusetts to Florida and in the Gulf of Mexico from Florida to northern Mexico (Lux and Mahoney, 1969; Mercer, 1984). Analyses of genetic population structure based on mtDNA control region sequences indicate that there are separate populations of red drum along the Gulf of Mexico and Atlantic coasts of Florida (Seyoum et al., 2000). This ecologically and economically important species is landed in large numbers from waters of the southeastern US Atlantic and Gulf of Mexico, principally by the recreational fishery. This species was landed commercially in Florida until 1989, when regulatory actions made the sale of native red drum illegal; however, the recreational fishery in Florida waters has remained substantial. Recreational landings from Florida waters totaled 410,904 fish (1,783,887 pounds) in 2002 (NMFS [1]).

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[1] NMFS. 2003. Personal commun. National Marine Fisheries Service. Fisheries Statistics and Economic Division, Silver Spring, MD 20910.

0025-326X/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.marpolbul.2004.10.049

Because of the large numbers of red drum landed by anglers in Florida waters and elsewhere within the southeastern United States, determining the levels of potential contaminants in this species is important for human health concerns. Mercury, a toxic metallic element, has been shown to bioaccumulate in fish tissue, and humans consuming fish can potentially consume significant levels of mercury. Methylmercury is the form of mercury most toxic to humans (NRC, 2000) and the majority of total mercury in fish muscle tissue (>95%) is in the monomethyl form (CH_3Hg) (Grieb et al., 1990; Bloom, 1992). Fish consumption has been positively correlated with mercury levels in humans (Choy et al., 2002; Hightower and Moore, 2003), and consumption of contaminated fish is the major known source of human exposure in the United States (NRC, 2000). Although mercury levels in red drum have been examined to a limited extent or from specific locations within Florida (Adams and McMichael, 2001; Strom and Graves, 2001; Adams et al., 2003) and from coastal areas elsewhere in the southeastern United States (Evans and Engel, 1994; Mathews, 1994; Watanabe et al., 2003), a comprehensive, statewide analysis of mercury levels in this species was needed.

During an ongoing study to better understand mercury contamination in marine fishes, the Florida Fish and Wildlife Conservation Commission–Fish and Wildlife Research Institute (FWC–FWRI) examined total mercury levels in muscle tissue from a wide variety of fish species from Florida waters, including red drum (Adams and McMichael, 2001; Adams et al., 2003). The initial results from this project were used by the Florida Department of Health (DOH) to issue a health advisory in January of 2003 urging limited consumption of red drum from the Florida Keys-Florida Bay area (DOH, 2003). The purposes of this study are to summarize total mercury levels in red drum from multiple study areas and regions within Florida waters; to determine spatial variations in mercury levels among study areas and regions; to examine the relationships between levels of mercury and fish size, sex, and age; and to better understand mercury contamination in relation to fisheries management of red drum populations.

2. Methods and materials

2.1. Sample collection and tissue analysis

Red drum analyzed in this study were collected from Florida estuaries and adjacent offshore waters by staff of FWC–FWRI's Fisheries-Independent Monitoring Program. Study areas included Choctawhatchee Bay, Apalachicola Bay, Cedar Key, Tampa Bay and its adjacent offshore waters, Charlotte Harbor, Shark River Slough-Everglades, Florida Keys-Florida Bay, and the Indian River Lagoon (Fig. 1). Samples were collected from April 1990 to April 2002.

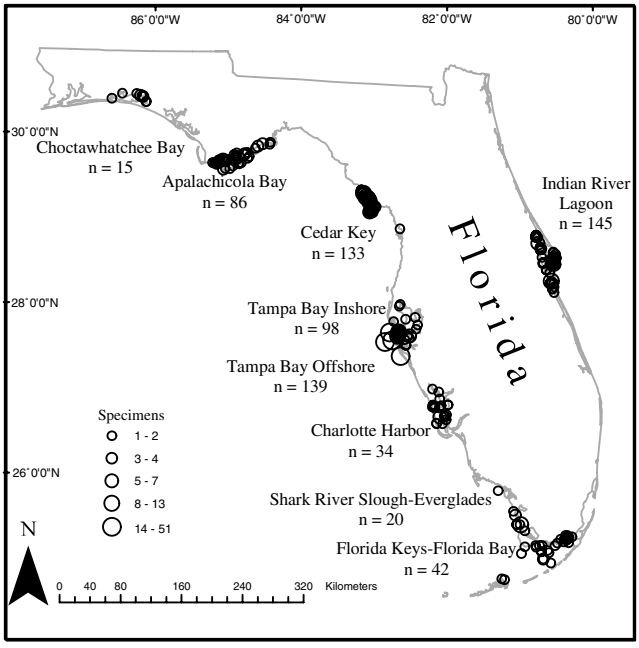

Fig. 1. Map of Florida study areas where red drum were collected for use in mercury analysis.

Fish were placed directly on ice and returned to the laboratory, where species, standard length (SL), and sex were recorded. Total fish weight was also recorded or extrapolated using weight-length regressions (Murphy and Taylor, 1990). When possible, stage of maturity was determined by histological or macroscopic examination of gonads. Age estimates were determined for a representative subsample of red drum by removing, processing, and examining saggital otoliths according to Murphy and Taylor (1990). For each fish, a clean stainless-steel knife was used to remove axial muscle tissue samples from the left dorsal area above the lateral line and anterior to the origin of the first dorsal fin. White muscle tissue taken from this region is representative of the portion of fish consumed by humans (Adams and McMichael, 2001). Care was taken to assure that the sample made no contact with epidermal or dermal layers, scales, or other surrounding surfaces during the extraction process. Tissue samples were immediately placed in sterile polyethylene vials and frozen at −20 °C until analyzed. Before analysis, tissue samples were digested using standard procedures in accord with US Environmental Protection Agency (EPA) Method 245.1 to convert all mercury in the sample to Hg(II) (EPA, 1991; Frick, 1996). The mercury in each digested sample was reduced to elemental mercury by reaction with excess stannous chloride. This elemental mercury was purged from solution in a gas–liquid separator and swept into an atomic absorption spectrometer for detection and quantification by cold vapor atomic