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A summary of total mercury concentrations in flora and fauna near common contaminant sources in the Gulf of Mexico

M. Lewis *, C. Chancy

United States Environmental Protection Agency, National Health and Environmental Effects, Research Laboratory, Gulf Ecology Division, 1 Sabine Island Drive, Gulf Breeze, FL 32561, USA

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Abstract

Total mercury concentrations are summarized for environmental media and biota collected from near-coastal areas, several impacted by contaminant sources common to the Gulf of Mexico. Water, sediment, fish, blue crabs, oysters, clams, mussels, periphyton and seagrasses were collected during 1993–2002 from targeted areas affected by point and non-point source contaminants. Mean concentrations in water and sediment were 0.02 (±1 standard deviation = 0.06) μg l^{-1} and 96.3 (230.8) ng g^{-1} dry wt, respectively. Mean total mercury concentrations in fish, blue crabs, brackish clams and mussels were significantly greater than those in sediment, seagrass, colonized periphyton and oysters. Concentrations (ng g^{-1} dry wt) averaged 23.1 (two seagrass species), 220.1 (oysters), 287.8 (colonized periphyton), 604.0 (four species of freshwater mussels), 772.4 (brackish clam), 857.9 (blue crabs) and 933.1 (nine fish species). Spatial, intraspecific and interspecific variability in results limited most generalizations concerning the relative mercury contributions of different stressor types. However, concentrations were significantly greater for some biota collected from areas receiving wastewater discharges and golf course runoff (fish), agricultural runoff (oysters) and urban stormwater runoff (colonized periphyton and sediment). Marine water quality criteria and proposed sediment quality guidelines were exceeded in 1–12% of total samples. At least one seafood consumption guideline, criteria or screening value were exceeded in edible tissues of blue crabs (6% total samples) and nine fish species (8–33% total samples) but all residues were less than the US Federal Drug Administration action limit of 1.0 ppm and the few reported toxic effect concentrations available for the targeted biota.
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Keywords: Total mercury; Bioaccumulation; Water; Sediment; Biota; Gulf of Mexico

1. Introduction

Contaminant concentrations in biotic tissues provide a time-integrated assessment of bioavailability and information on fate and distribution in the environment (Sijm and Hermens, 2000). For these reasons, contaminant residues in flora and fauna have been used frequently as an indicator of environmental quality (O'Connor, 2002). Mercury has no known biological function and it is considered a persistent bioaccumulative and toxic pollutant. Mercury is a mutagen, teratogen, and carcinogen (Eisler, 1987) and forms of mercury are transformed into methylmercury which is bioconcentrated by saltwater biota and magnified through trophic food chains. The presence of methylmercury in seafood is of public concern since it may cause a range of human neurological effects (USEPA, 2001a). Fifteen states have issued consumption advisories for mercury in coastal waters (USEPA, 2007). Approximately, 65% of the US coastline is under a mercury advisory. This includes the entire coastline of the Gulf of Mexico.

Understanding the fate of mercury in near-coastal ecosystems has been a research focus for many years (USEPA, 2001b) but information is still less available than that for

* Corresponding author. Tel.: +1 850 934 9382.
E-mail address: lewis.michael@epa.gov (M. Lewis).

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freshwater habitats. Multiple surveys have been conducted to determine mercury distribution at various geographical scales in the Gulf of Mexico. The targeted media of these surveys have been commercial species of finfish and shellfish and, to a lesser extent, sediment and water (NOAA, 1997; Adams et al., 2003; Cunningham et al., 2003). Multimedia monitoring, however, has been limited in most previous surveys, particularly those conducted in targeted coastal areas impacted by different stressor sources. Thus, apportioning the contributions of mercury from common stressor sources and assessing the risk to species representing different trophic levels remain important research issues.

A series of surveys were conducted during 1993–2002 (described in Lewis, 2004) at several coastal areas of the Gulf of Mexico to determine ecological condition. A variety of chemical and biological indicators were used that included measurements of mercury bioaccumulation. The objectives of this summary are to provide an overview of the mercury results relative to biotic type and collection location, and to report the frequency of exceedance of environmental and human health guidelines. The information is useful as a reference data base for future comparisons, particularly for species not normally included in mercury monitoring surveys. In addition, the data support the 303 (d) listing process for impaired waters and TMDL development (USEPA, 2005) by providing site-specific information for mercury contamination in multiple biota and by providing a perspective on the ability to differentiate sources of mercury contamination within watersheds.

2. Experimental

2.1. Study areas

Seven to 262 samples of water, sediment and biota were collected one to three times from 27 locations during 1993–2002 (Fig. 1, Table 1). Many of the nonrandom sampling sites (range = 18–151 for different media) were targeted to near-shore areas receiving anthropogenic contaminants from four common stressor sources. Sampling sites were located in three bayous that receive urban storm water runoff, coastal rivers and bays below or adjacent to 10 municipal, industrial and pulp mill discharges, areas adjacent to a coastal golf course complex and in agriculturally-impacted water management canals and the adjacent Everglades–Florida Bay transitional zone. In addition, media were collected from seagrass beds (Lewis et al., 2007) and from proposed sediment reference areas (Lewis et al., 2006), including estuarine areas of the Suwanee and Withlacoochee Rivers which are Florida outstanding waters, a special designation intended to protect existing good water quality.

2.2. Sampling techniques and biota

One hundred and forty-six water samples were collected at 1.0 m incremental depths. Samples at each site were composited before analysis. Two hundred and sixty-two sediment samples were collected with a petite ponar grab to a depth of 13 cm and homogenized before analysis. Storage and preservation techniques for water and sediment followed standard procedures (APHA, 1998). Mercury

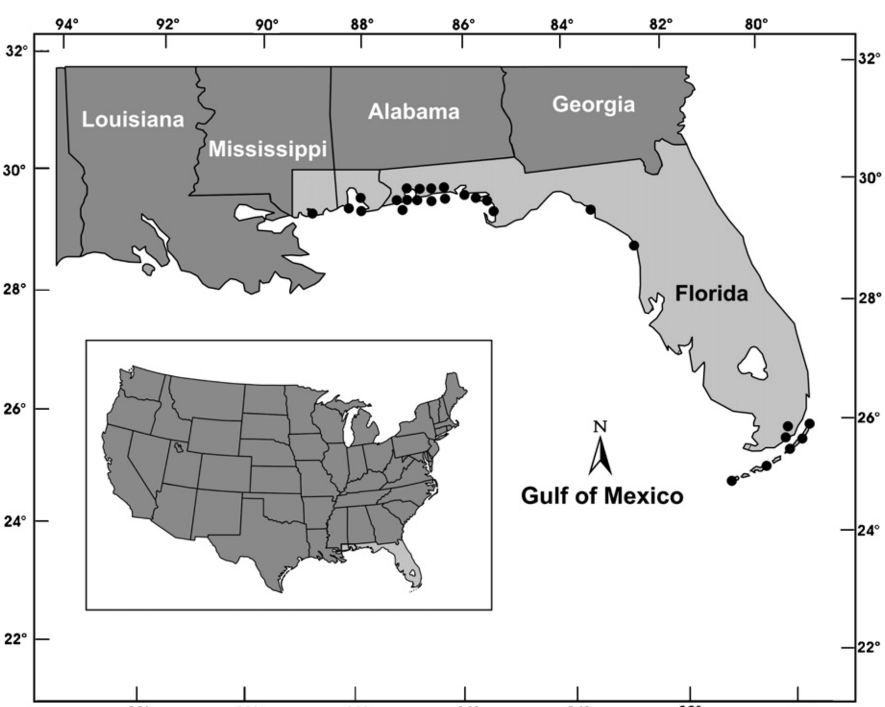

Fig. 1. The 27 sampling locations in near-coastal areas of the Gulf of Mexico. See Table 1 for additional details.