U.S. Department of the Interior
U.S. Geological Survey

Occurrence of Polycyclic Aromatic Hydrocarbons in Urban Streams as Assessed Using Semipermeable Membrane Devices, Dallas-Fort Worth Metropolitan Area, Texas

One of the primary goals of the U.S. Geological Survey's National Water Quality Assessment (NAWQA) Program is to determine the occurrence and distribution of contaminants in stream sediments and tissues of aquatic organisms (Crawford and Luoma, 1993). Metals and persistent organic contaminants are of principal concern.

Polycyclic aromatic hydrocarbons (PAHs) are a group of organic compounds that occur abundantly in the environment, are toxic and often carcinogenic to organisms, and could represent a long-term source of contamination. PAHs are metabolized and excreted by most higher vertebrates, particularly fishes, often making assessment of tissues concentrations impossible. Major sources of PAHs are the incomplete combustion of carbonaceous materials and oil spills.

The objectives of this fact sheet are to summarize the occurrence of water-borne PAHs in three urban streams in the Dallas-Fort Worth metropolitan area and to assess the use of semipermeable membrane devices (SPMDs) as PAH samplers. One site on each of three streams was selected for monitoring the occurrence of PAHs (fig. 1). The sites were chosen to reflect varied urban land uses and the influences of point- and nonpoint-source pollution. The monitoring was done using SPMDs during a 30-day period in late May and June 1994.

WHAT ARE SEMIPERMEABLE MEMBRANE DEVICES?

SPMD technology (Huckins and others, 1990) is new. An SPMD simulates the exposure to and passive uptake of highly lipid-soluble organic compounds by biological membranes. Potential applications include the simulation of absorption by biological membranes of dissolved organic compounds from surface water, bed sediments, and ground water. An SPMD typically consists of a long strip of low-density, polyethylene tubing filled with a thin film of a purified lipid such as triolein. The long strip of tubing and lipid film provide a large surface-area-to-volume ratio that simulates a biological membrane such as a fish's gill. The SPMDs used in this study concentrate PAHs above ambient concentrations and simulate biological exposure so that the potential bioconcentration of PAHs over a controlled exposure period can be estimated.

POLYCYCLIC AROMATIC HYDROCARBONS DETECTED

Twenty-five PAHs were concentrated in the SPMDs across all sites (fig. 2). Twenty-three were detected at the Trinity River below Dallas and White Rock Creek sites, and 21 were detected at the West Fork Trinity River site. Seventy-three percent of the PAHs from the White Rock Creek and Trinity River below Dallas sites and 67 percent from the West Fork Trinity River site were substituted PAHs—that is, with one or more substituted alkyl groups attached. The largest concentrations were of the more water soluble and volatile PAHs such as fluoranthene, chrysene, pyrene, and phenanthrene; and concentrations of these PAHs were consistently largest at the White Rock Creek site and smallest at the West Fork Trinity River site.

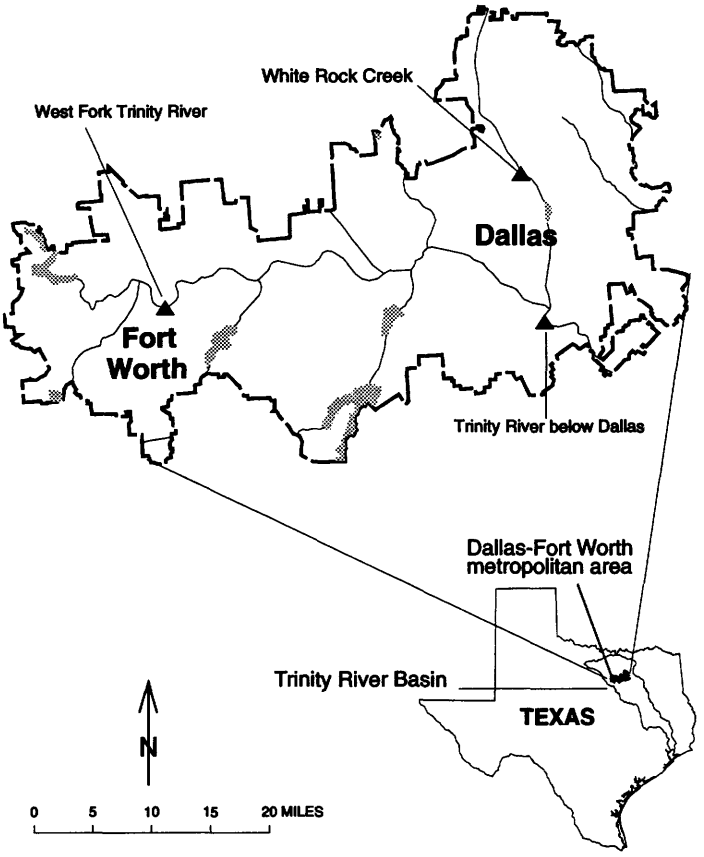

Figure 1. Location of semipermeable membrane device deployment sites in the Dallas-Fort Worth metropolitan area.

HAZARDOUS POLYCYCLIC AROMATIC HYDROCARBONS DETECTED

The Public Health Service's Agency for Toxic Substances and Disease Registry (ATSDR), in cooperation with the U.S. Environmental Protection Agency, has developed a comprehensive ranking of 275 hazardous substances based on their frequency of occurrence at hazardous wastes sites, toxicity, and potential for human exposure (Agency for Toxic Substances and Disease Registry, 1994). Nine of the PAHs concentrated by the SPMDs in this study have been ranked by ATSDR (table 1). Benzo(a)pyrene and benzo(b)fluoranthene are ranked in the top 10. Benz-(a)-anthracene, fluoranthene, chrysene, acenapthene, and phenanthrene, in that order, are ranked in the top 200; pyrene and anthracene are ranked 201 and 235, respectively.

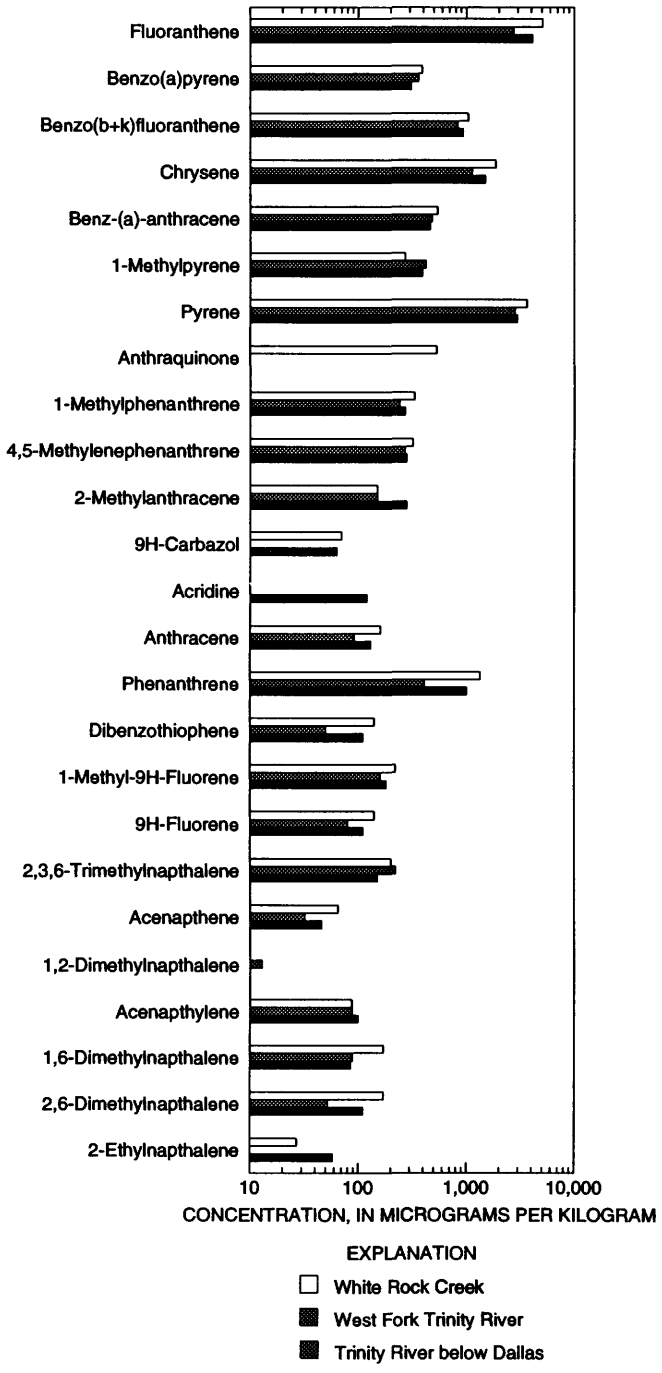

Figure 2. Polycyclic aromatic hydrocarbons detected in semi-permeable membrane devices in three urban streams in the Dallas-Fort Worth metropolitan area.

IMPORTANCE OF FINDINGS

The results of this study indicate that aquatic organisms at three sites near Dallas are exposed to toxic PAH compounds. The SPMD is an effective tool to detect hydrophobic organics in water: The low concentrations of the compounds in the streams might not be detected by more traditional water-sampling techniques such as a single water grab sample taken at a regular time interval.

Table 1. Hazardous polycyclic aromatic hydrocarbons concentrated by semipermeable membrane devices

[ASTDR, Agency for Toxic Substances and Disease Registry]

Compound	ASTDR Ranking
Benzo(a)pyrene	8
Benzo(b)fluoranthene	10
Benz-(a)-anthracene	35
Fluoranthene	100
Chrysene	110
Acenapthene	140
Phenanthrene	188
Pyrene	201
Anthracene	235

SELECTED REFERENCES

Agency for Toxic Substances and Disease Registry, 1994, 1993 CERCLA priority list of hazardous substances that will be the subject of toxicological profiles & support document: U.S. Public Health Service, 34 p.

Crawford, K.S., and Luoma, S.N., 1993, Guidelines for studies of contaminants in biological tissues for the National Water Quality Assessment Program: U.S. Geological Survey Open-File Report 92–494, 69 p.

Huckins, J.N., Tubergen, M.W., and Manuweera, G.K., 1990, Semipermeable membrane devices containing model lipid—a new approach to monitoring the bioavailability of lipophilic contaminants and estimating their bioconcentration potential: Chemosphere, v. 20, no. 5, p. 533–552.

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Information on technical reports and hydrologic data related to the NAWQA Program can be obtained from:

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In 1991, the U.S. Geological Survey, U.S. Department of the Interior, began a National Water-Quality Assessment (NAWQA) Program. The long-term goals of the NAWQA Program are to describe the status of and trends in the quality of a large representative part of the Nation's surface- and ground-water resources and to identify the major factors that affect the quality of these resources. In addressing these goals, NAWQA will produce water-quality information that is useful to policymakers and managers at Federal, State and local levels.

Studies of 60 hydrologic systems that include parts of most major river basins and aquifer systems are the building blocks of the national assessment. The 60 study units range in size from less than 1,000 to more than 60,000 square miles and represent 60 to 70 percent of the Nation's water use and population served by public water supplies. Twenty investigations began in 1991, 15 investigations began in 1994, and 20 are scheduled to begin in 1997.