Fact Sheet FS-110-97

ORGANOCHLORINE PESTICIDES AND PCBs IN SOUTHERN FLORIDA FISHES: THEN AND NOW

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Organochlorine pesticide residues, including DDT and its degradation products, have remained prevalent in freshwater fishes in southern Florida over the last 25 years. Highest concentrations of pesticides and PCBs were found and continue to be found in fishes from canals of the northern Everglades.

INTRODUCTION

The occurrence of pesticides and other organic compounds in southern Florida has been the focus of environmental studies for at least 25 years. Pesticides and polychlorinated biphenyls (PCBs) are of environmental concern because of their potential toxic effects on humans and wildlife. At high concentrations, pesticides and PCBs may cause acute mortality. At lower, chronic concentrations they may cause impairment through processes such as cancer and reproductive disruption (Colborn and others, 1993). Successful efforts to protect human health and the biotic integrity of southern Florida ecosystems are dependent on an improved and expanded understanding of the effects of pesticides used in the region.

Pesticides have been used in agricultural and urban areas in southern Florida for more than 50 years. However, the types and amounts of pesticides have changed over time, because of changes in technology, State and Federal regulations, and changes in land use. Pesticide application is closely related to land use (fig. 1). Beginning in the late 1960's and early 1970's, persistent organochlorine pesticides have been detected in fish that are a part of the Everglades food chain (Kolipinski and Higer, 1969; Ogden and others, 1974; and McPherson, 1973).

PCBs were manufactured in the United States from 1929-79. They were used in the production of plastics, paints, and adhesives, and as pesticide additives. They are still commonly found as insulating and cooling fluids in electrical transformers and capacitors.

In recent years, many organochlorine pesticides and PCBs have been linked to hormone disruption and reproductive problems in aquatic invertebrates, fishes, birds, and mammals (Colborn and others, 1993). Most of the organochlorine pesticides are no longer sold in the United.States. For example, DDT was banned for use in the United States in 1972 following reports that it causes eggshell thinning in some birds; chlordane was banned from sale in the United States in 1988. However, organochlorine pesticides are still found in the environment and continue to pose potential threats to wildlife and humans.

Several agencies and organizations have undertaken recent monitoring efforts to document the occurrence of pesticides in water, bed sediment, and animal tissue in southern Florida. The South Florida Water Management District (SFWMD) began monitoring pesticides in water and bottom sediment in southern Florida in the mid 1980's (Pfeuffer, 1985, 1991). The U.S. Geological Survey (USGS), through its National Water Quality Assessment (NAWQA) program, is measuring the occurrence of pesticides in water at several sites and has conducted pesticide occurrence surveys in bottom sediment and fishes since 1995.

The objective of this report is to compare concentrations of pesticides and PCBs in fishes collected in 1995 in southern Florida with concentrations measured in fishes collected in the 1970's, when environmental data on these contaminants first became available. There are limitations in comparing historic data with recent NAWQA data. For example, collection sites are not identical, and methods of sample analysis are not precisely the same over this time span. However, a general comparison of historic and recent data is useful because it can indicate geographic areas where contaminant concentrations remain high, and it can document the persistence of selected compounds which have been banned from use.

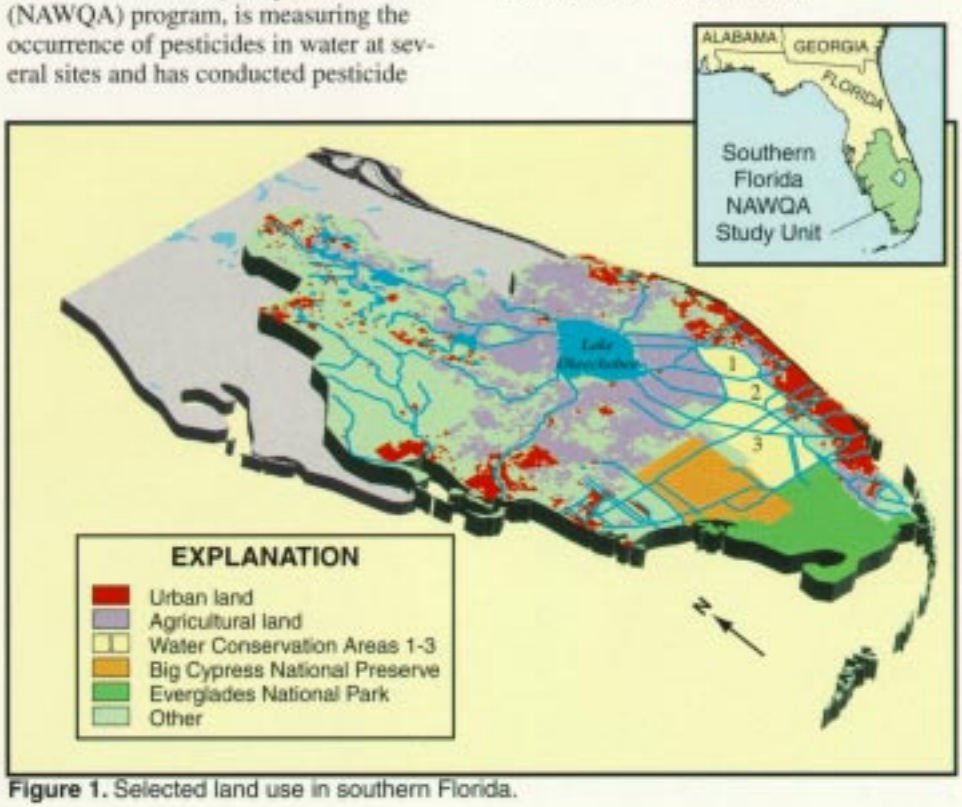

Figure 1. Selected land use in southern Florida.

METHODS

The SFWMD sampled largemouth bass (*Micropterus salmoides*), redear sunfish (*Lepomis microlophus*), and lake chubsucker (*Erimyzon sucetta*) during 1970-73 at sites in the northern and southern Everglades (McPherson, 1973). Fishes collected during 1970-73 were analyzed for pesticides at the USGS Water Quality Laboratory in Washington, D.C. and at the Department of Health, Education and Welfare, Public Health Service, Food and Drug Administration Laboratory in Atlanta, Ga. (McPherson, 1973). Fish samples consisted of whole fish and most samples were composites of 5-10 individual fish of the same species. The SFWMD again collected largemouth bass, redear sunfish, and lake chubsucker at sites in central and southern Florida in 1978 (Milleson, 1980). These composite samples of whole fish were analyzed for pesticides at the USGS Atlanta Central Water Quality Laboratory (Milleson, 1980). The USGS collected largemouth bass and Florida gar (*Lepisosteus platyrhincus*) at 19 sites in southern Florida during August through December 1995, as a part of the Southern Florida NAWQA project. Composite samples of whole fish were analyzed for pesticides at the USGS National Water Quality Laboratory in Denver, Colo. Procedures for processing and analyses of these fish-tissue samples are described in Crawford and Luoma (1993), and in Leiker and others (1995).

RESULTS

DDT or its degradation products (DDE and DDD) were detected in 49 composite fish samples collected from 12 sites during 1970-73; concentrations ranged from 6 to 800 micrograms per kilogram (µg/kg) total DDT (figs. 2 and 3). Concentrations of total DDT in 23 composite fish samples collected in 1978 ranged from 3 to 1,650 µg/kg, with the highest concentration in a sample of redear sunfish. In these two studies, highest concentrations of DDT and its degradation products were in fish from canals that surround or separate Water Conservation Areas (WCA) 1 and 2 (fig. 1).

In 1995, DDT or its degradation products were detected in 25 of 27 fish samples from 15 sites in southern Florida (figs. 2 and 3). Concentrations of total DDT ranged from less than 5 to 1,170 µg/kg in Florida gar and from less than 5 to 610 µg/kg in largemouth bass. The most commonly detected and abundant DDT degradation product was p,p'-DDE (fig. 4). Highest concentrations of total DDT in fishes collected in 1995 were detected in canals of the northern Everglades near agricultural lands.

Dieldrin and toxaphene were two other pesticides commonly detected in the early 1970s in fishes from the Everglades. Concentrations of dieldrin in largemouth bass were as high as 130 µg/kg and concentrations of toxaphene were as high as 5,000 µg/kg. In 1995, dieldrin was detected in 5 of the 27 fish samples collected, and concentrations ranged from less than 5 to 18 µg/kg (table 1). Toxaphene was not detected in fish samples collected in 1995, but minimum detection levels were less than 200 µg/kg. Other pesticides detected in fish tissue in 1995 included: oxychlordane, trans-nonachlor, cis-nonachlor, mirex, trans-chlordane, and cis-chlordane. During the 1970's and in 1995, pesticides were most frequently detected and present in highest concentrations in fish from canals of the northern Everglades.

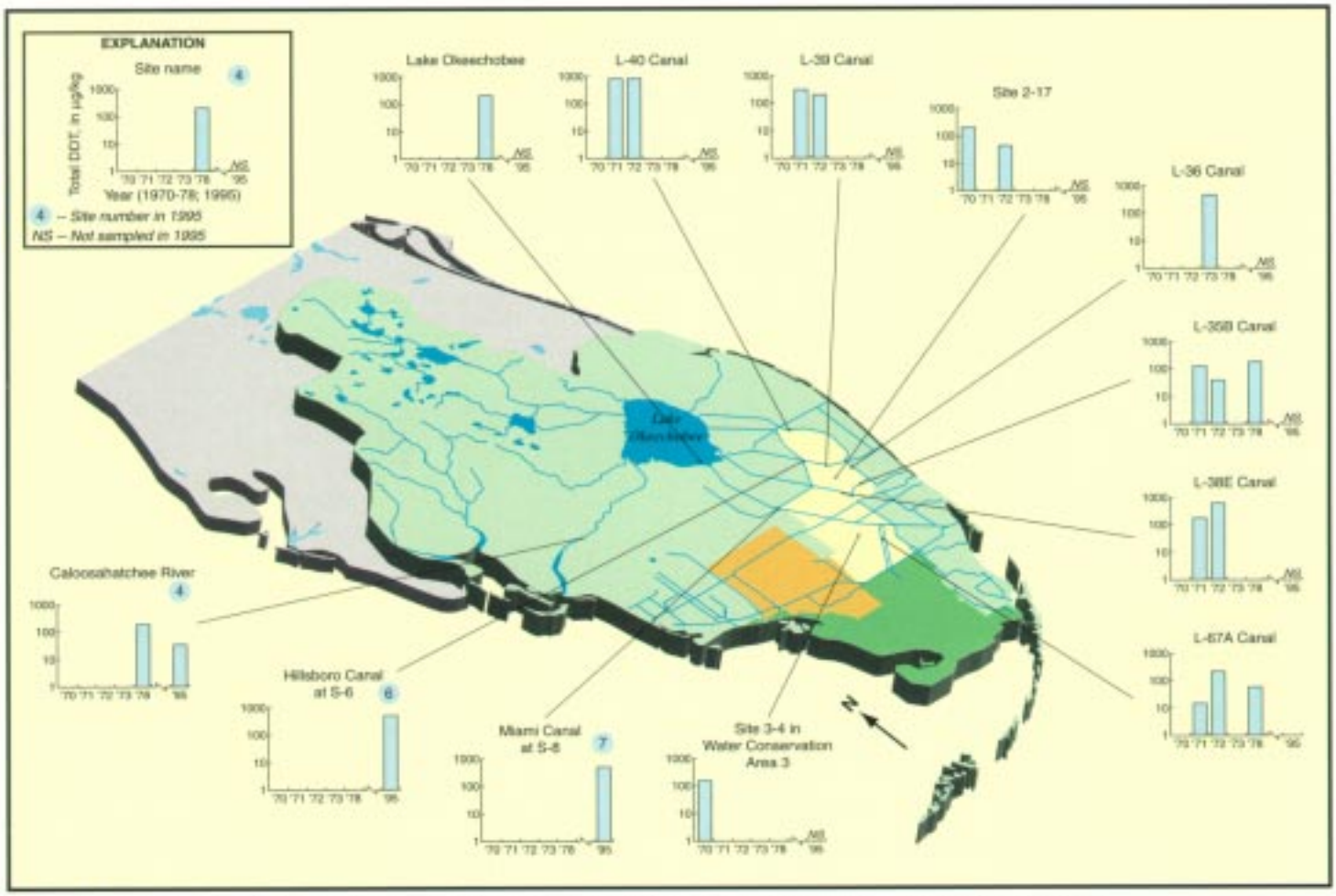

Figure 2. Concentration of total DDT in largemouth bass at locations where concentrations exceeded 100 µg/kg.

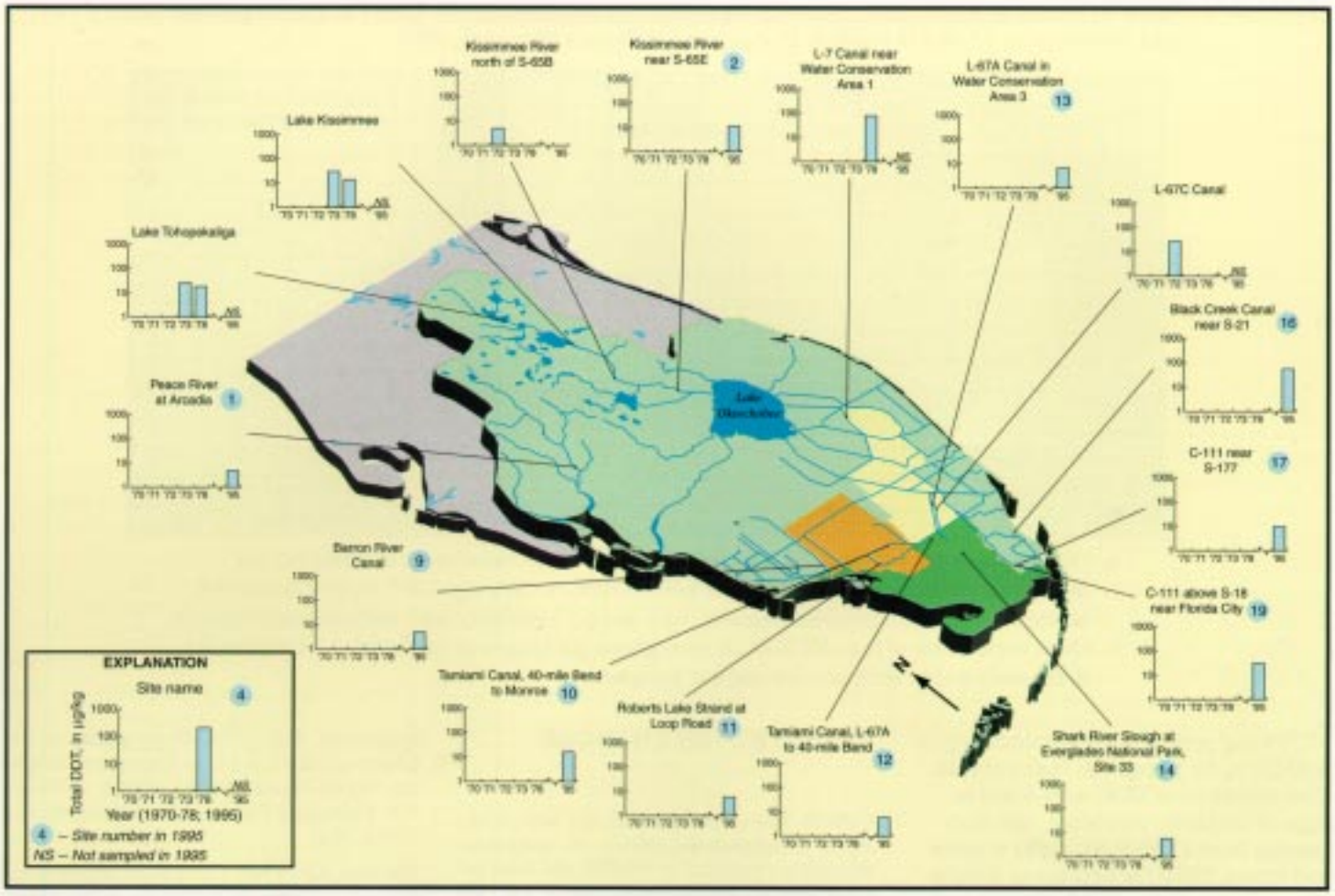

Figure 3. Concentration of total DDT in largemouth bass at locations where concentrations were less than 100 µg/kg.

PCBs were detected in most fish samples collected in the 1970s, and concentrations ranged from 50 to 260 µg/kg. PCBs were detected in 3 of 27 fish samples collected in 1995 and concentrations ranged from less than 50 µg/kg to 140 µg/kg. The highest PCB concentration in 1995 occurred in a largemouth bass sample collected from Black Creek Canal (table 1), which flows through a highly urbanized area of southeastern Florida.

DISCUSSION

Recently, a consensus has developed among Federal and State agencies and environmentalists that the southern Florida ecosystem, and the remaining Everglades in particular, should be protected and restored, to the extent possible, to its predevelopment conditions. The primary goals of restoration include the delivery of adequate amounts of good quality water at appropriate times of the year to sustain the natural ecosystem. Efforts are underway to define the quantity, timing, and quality of water required for sustainability. Thus far, most efforts in relation to water quality have been directed toward defining acceptable concentrations of nutrients, principally phosphorus. Much less is known about the occurrence and potential effects of toxic substances on the ecosystem. Studies are underway to define the extent and sources of mercury contamination in the region. In contrast, little has been done thus far to define and understand effects of pesticides and other organic compounds on the ecosystem, although it is well-known that these chemicals can decimate wildlife populations through direct lethal effects and through more subtle long-term effects on reproduction and survival (Colborn and others, 1993). It has been known since the early

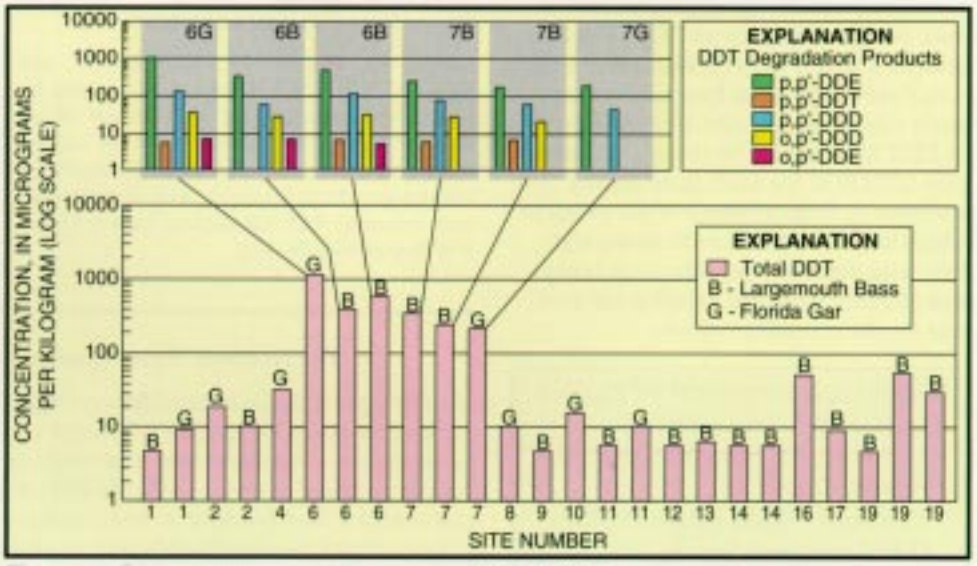

Figure 4. Concentration of DDT and degradation products in southern Florida fishes in 1995. Fish at sites 6 and 7 had multiple DDT degradation products; total DDT at all other sites was principally p,p' DDE.

Table 1. Pesticides and organic compounds detected in composite samples (whole fish) of largemouth bass and Florida gar at 15 sites in southern Florida, August through December, 1995.

Compound[ab]	Minimum detection limit (MDL), in µg/kg	Number of detections above MDL	Maximum concentration, in µg/kg	Location of maximum concentration
cis-Chlordane	5.0	4	12	Hillsboro Canal at S-6
oxy-Chlordane	5.0	1	5.6	Miami Canal at S-8
trans-Chlordane	5.0	3	6.6	Hillsboro Canal at S-6
o,p'-DDD	5.0	5	34	Hillsboro Canal at S-6
p,p'-DDD	5.0	6	120	Hillsboro Canal at S-6
p,p'-DDE	5.0	25	1000.0	Hillsboro Canal at S-6
o,p'-DDE	5.0	3	6.9	Hillsboro Canal at S-6
p,p'-DDT	5.0	4	6.6	Hillsboro Canal at S-6
Dieldrin	5.0	5	18	Hillsboro Canal at S-6
Mirex	5.0	1	12	Peace River at Arcadia
trans-Nonachlor	5.0	5	19	Hillsboro Canal at S-6
cis-Nonachlor	5.0	3	7	Hillsboro Canal at S-6
PCBs	50.0	3	140	Black Creek Canal

a. Other compounds with an MDL of 5.0 µg/kg that were included in the analyses but not detected are: aldrin, α-BHC, β-BHC, δ-BHC, γ-BHC, DCPA, o,p'-DDT, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, o,p'- and p,p' -methoxychlor, and pentachloroanisole

b. Other compounds with an MDL of 50 micrograms per kilograms (µg/kg) that were included in the analyses but were not detected are: toxaphene

1970's that pesticides are accumulating in wildlife of the Everglades National Park. Concentrations of DDE were found in eggs of alligators, crocodiles, and birds ranging from 1,000-5,500 µg/kg (Ogden and others, 1974). Scientists and environmentalists are concerned that toxins such as pesticides may be responsible, along with loss of wetlands habitat, for the large declines in wading bird populations in southern Florida over the last 50 years.

Major goals of Everglades restoration could be met with regard to adequate amounts of water delivered at appropriate times of the year, and yet this delivery could fail to sustain the natural system because of unforeseen adverse affects of toxic compounds, such as DDE. The data presented in this report indicate that DDE is still prevalent in the Everglades food chain more than 25 years after application of DDT has ended. The sources and transport of DDE in the food chain are not understood. Determination of the extent to which toxins are in the food chain, and their long-term adverse effects on ecosystem integrity would be valuable information for the restoration effort.

Hydrologic data and other information related to the Southern Florida NAWQA project can be obtained from:

Project Chief
Southern Florida NAWQA Study
U.S. Geological Survey
4710 Eisenhower Blvd., Suite B5
Tampa, FL 33634

SELECTED REFERENCES

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The National Water Quality Assessment (NAWQA) Program

In 1991, the U.S. Geological Survey began the NAWQA Program 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 natural and human factors that affect the quality of these resources. The NAWQA Program is designed to produce water-quality information that is useful to policymakers and managers at Federal, State, and local levels. The 60 proposed study units represent 60 to 70 percent of the Nation's water use and population served by public water supplies. The Southern Florida study was begun in 1994.